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ICT and Productivity: The Situation in France

The contribution of information and communication technologies (ICT) to French growth rose strongly during the second half of the 1990s. The lag with the United States does not appear to be detrimental to progress in total factor productivity. Such progress is especially important in sectors which themselves produce new technology, but it is also spreading to other sectors. But, contrary to what might be expected, the strongest productivity gains are not occurring in those activities which invest in ICTs the most. Apart from problems of measuring the phenomenon, this paradox is mainly to be explained by the companies' organisational requirements and by adaptations in the use of labour

The investment boom in new technology and America's exceptional growth in the second half of the 1990s were accompanied by accelerated productivity gains, leading to a substantial debate on the impact of ICT on growth. Are these new technologies liable to raise the pace of technological progress shifting economies on to a higher, long term growth path? Will Europe's lag in the production and diffusion of new technologies lead to a permanent gap in potential growth rates on the two sides of the Atlantic? To contribute to this debate, and as part of an international project, the CEPII has been involved in a macroeconomic and sectoral study of the contribution of ICT to growth in France. The first results of this research are presented here[1].

ICT as a Factor of Production

Growth in GDP can be broken down into the contributions of the various factors involved in production, with ICT equipment being isolated as one of these factors (see Box). Growth in production which is not explained by the rise in one or another of these production factors corresponds to a general gain in total factor productivity (TFP), which is largely assimilated with technical progress[2].

The issue of the price-volume distribution of value data is crucial in determining the contribution of ICT to growth, as well as the productivity gains associated with it. Given that comparing prices over time is very difficult in an area characterised by innovation and rapid change in product quality, national accounts assess prices of some ICT products using the so-called hedonic method. The latter estimates prices based on product characteristics (for example, the memory capacity of computers). In France, this method is used in some areas of computer equipment (personal computers and printers), while it is used more widely in the United States. To make the data more compatible, the spread observed between ICT and non- ICT capital equipment in US price data time series has been applied here to France[3]. The volume of ICT investment and especially investment in computer equipment calculated in this way is higher than data given by INSEE (France's National Institute for Statistics and Economies Studies - see Graph).

1. J. Melka, L. Nayman, S. Zignago & N. Mulder (2003), "An Analysis of ICT Impact on French Growth", *CEPII Working Paper*, forthcoming.
2. This residual of the production function includes not only deviations relative to assumptions made about the production function, but also failings linked to measuring factors of production, and even variations in productivity due to cyclical factors. Correcting for all these errors and biases makes it possible to isolate autonomous technical progress, "free spillovers" due to technological and organisational innovations within an economy.
3. This method was proposed by P. Schreyer (2000), "The Contribution of Information and Communication Technology to Output Growth: a Study of the G7 Countries", *STI Working Paper* 2000/2, OECD.

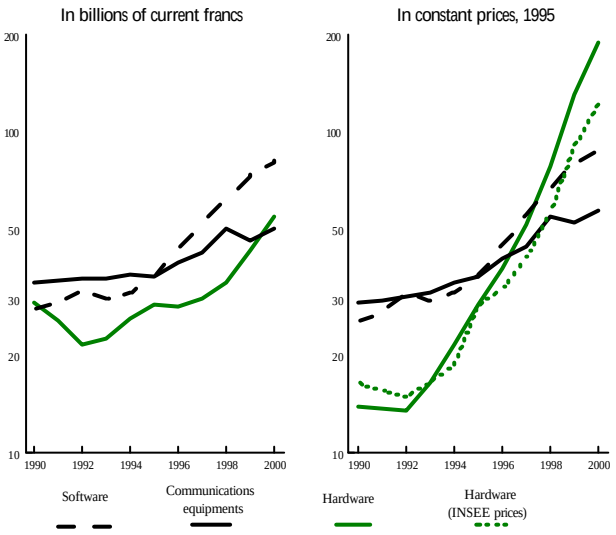
BOX 1 — GROWTH ACCOUNTING

The construction of data series on capital services and labour services are based on D. Jorgenson's method. The aim is to obtain series for services of both factors which include quality effects due to changes in their composition. The services constitute flows of capital or labour weighted respectively by user cost or by the compensation of each category of capital or labour.

Six types of non-residential capital are identified: IT equipment, communications equipment and software make up ICT capital. Other types of capital are divided among non-residential buildings, transport equipment and non-ICT equipment. The weighting scheme of each type of asset stems from its rate of return, its rate of depreciation as well as rises and falls in capital value.

The labour factor is measured in hours, characterised by sex and age (4 age groups) and the qualifications (6 levels) of persons employed. Labour services, which are calculated by weighting the growth rates of hours worked by the remuneration of each category in question, reflect the productivity of different categories of labour. This involves assuming that a better-compensated category (employees over 45 years old and highly qualified) will create more labour services in one hour than a less-well-paid employee (a young person without qualifications). The gap in growth between labour services (which takes into account the breakdown of hours worked) and the number of hours worked shows up changes in the quality of labour as an explanatory variable in productivity gains.

Graph — ICT investment in France



Source: INSEE, BEA and authors' calculations.

The Lag in French ICT Investment Worrying?

The share of ICT investment in non-residential investment was two and half times as high in the United States as in France, in the early 1980s. Thereafter, growth in ICT investment in both countries was quite comparable, except in the years 1991-1995 when slow growth accentuated France's lag, especially in respect to IT hardware (Table 1).

Table 1 — Investment in ICT

In %	France					United States				
	Average annual growth in volume*				Share of ICT in investment**	Average annual growth in volume*				Share of ICT in investment**
	IT hardware	Software	Communi-cations equipments	Total ICT		IT hardware	Software	Communi-cations equipments	Total ICT	
1983-1990	30.7	13.0	9.8	20.9	8.8	25.6	16.2	4.2	19.3	21.6
1991-1995	15.8	6.7	4.0	9.3	9.0	28.2	12.3	6.4	17.0	24.6
1996-2000	45.6	19.7	9.8	20.2	12.3	42.6	18.0	17.6	22.3	27.4

Notes: *Calculated using the Schreyer method. ** Share in value in non-residential
Source: INSEE, CEPII, authors' calculations and University of Groeningen.

The strong rise in ICT investment in France during the second half of the 1990s led to a marked increase in the contribution of ICT capital to growth, up from 0.21 points to 0.46 points. This contribution is all the more remarkable given that a correction in the form of growth was occurring. After a period of strong capital substitution for labour, the upturn between 1996 and 2000 was based in fact on a strong contribution by labour services, which characterises an increasing labour content of growth, and in strong rises in total factor productivity, which typifies a better productive combination (Table 2).

Table 2 — Contributions to growth

	France			United States	
	1983-1990	1991-1995	1996-2000	1991-1995	1996-2000
Value added (average annual rate of growth in %)	2.57	1.09	2.65	2.35	4.20
Contributions to value added growth (in percentage points)					
- Capital services	1.22	0.96	1.07	1.25	2.27
of which ICT capital	*0.23*	*0.21*	*0.46*	*0.55*	*1.11*
other capital	*0.99*	*0.75*	*0.61*	*0.7*	*1.16*
. Labour services	0.72	0.06	0.62	0.86	1.30
. TFP	0.63	0.06	0.96	0.23	0.63

Source: For France, J. Melka *et al.*, *op. cit.*, for the United States, D.W. Jorgenson, M.S. Ho & K.J. Stiroh (2002), "Growth of US Industries and Investments in Information Technology and Higher Education", *Mimeo*, <www.economics.harvard.edu>.

The US economy experienced a sharp rise in growth in 1996-2000, helped by the strong, dynamic interaction of several factors that are now well identified (an accommodating monetary policy, finance for private agents, capital inflows etc.). According to the OECD, actual growth in the United States exceeded its potential by 1.2%, whereas for France it remained below potential by 1.7%. America's extensive form of growth is based on increases in all types of capital and labour services, including non-ICT capital (which was not the case for France).

Total factor productivity accelerated notably in both countries, but hourly productivity gains only rose in the United States[4] (Table 3). At this point, it is therefore difficult to conclude that France is suffering from investment lags in ICT which are detrimental to the growth of its TFP, though the small increase in labour productivity does raise some questions. Differentiating sectors in France makes it possible to provide a more detailed diagnosis of the relationship between the spread of ICT and productivity improvements.

Table 3 — Contributions to the hourly labour productivity gains

	France			United States	
	1983-1990	1991-1995	1996-2000	1991-1995	1996-2000
Hourly labour productivity (average annual growth rate in %)	2.6	1.80	2.16	1.28	2.21
Contributions to hourly labour productivity growth (in % points)					
. ICT capital intensity	0.28	0.25	0.45	0.49	1,00
. Other capital intensity	0.93	0.94	0.45	0.32	0.40
. Labour quality	0.76	0.54	0.29	0.24	0.17
. TFP	0.63	0.06	0.96	0.23	0.63

Source: See Table 2.

What Are the Weaknesses of Sectors Using ICT?

ICT may be a source of productivity gains when they are produced and when they are utilised. Empirical studies of the US economy have observed the presence of important productivity gains within the ICT manufacturing sector itself, but their presence outside this sector is debatable. What can be said for France? If productivity benefits are largely limited to the production of ICT, then the positive impact to be expected from ICT will be limited due to the relatively small size of this sector in French GDP.

Before presenting the results here, it should be recalled that the conventions adopted for estimating price changes of ICT products affect the nature and the sharing out of productivity gains across the ICT producing and using sectors[5]. If the improvement in the quality of ICT products is not taken into account in their prices, then their greater effectiveness does not show up in the volume of production in the ICT producer sector, nor in the investment volume in the user sector: it shows up in the TFP of the user sector. In contrast, if the increased quality of ICT goods is taken into account in prices (as is the case with hedonic calculations), then it leads to a stronger rise in the production and TFP of the ICT producer sector. In the user sector, labour productivity is improved by greater ICT capital intensity. But apart from the mechanism used to calculate prices, TFP gains are also to be expected in this sector, as the utilisation of ICT improves the overall efficiency of production processes.

During the period 1996-2000, the ICT producer sector (see Box 2) did indeed record very strong gains in output per hour worked (10.7% per year), stemming from total factor productivity growth (Table 4). Given its weight in value added (3.5%), this sector contributed 40% of the TFP gains of the whole economy.

BOX 2 — ICT PRODUCER AND HEAVY USER SECTORS

The ICT producer sector covers branches making computer hardware and office equipment, communications equipment and services (headings 30, 32 and 64 of the NACE rev. 1). Computer services, including business services (about 30% of the total), cannot be separated out, and so are not included in the producer sector (they are included among the ICT heavy user sector).

The heavy user sector draws together all those branches whose ICT intensity in 1996-2000 was greater than the average of the sector to which they belong: chemicals and mechanical machinery for the manufacturing sector; and among services: banking services, business services, personal services, real estate, financial intermediation services and insurance; lastly, electricity, gas and water.

Table 4 — Sources of hourly productivity in ICT producer and heavy user sectors, in France

	1983-1990		1991-1995		1996-2000	
	Producer	Heavy user	Producer	Heavy user	Producer	Heavy user
Hourly labour productivity (annual average rate of growth, in %)	6.74	0.46	5.47	0.86	10.66	0.91
Contributions to hourly labour productivity growth (in percentage points)						
. ICT capital intensity	0.28	0.44	0.17	0.28	0.25	0.58
. Other capital intensity	1.73	0.24	1.11	2.15	-0.56	0.92
. Labour quality	0.14	0.15	0.14	0	-0.27	-0.05
. TFP	4.59	-0.36	4.06	-1.57	11.24	-0.54

Source: CEPII, authors' calculations.

However, expected TFP gains are not to be found in the sector which uses ICT heavily. On the contrary, the contribution of TFP is negative in this sector. Moreover, data at the branch level do not provide evidence of a link between ICT capital intensity and TFP: activities which experienced the largest rises in productivity throughout the

4. The result for France obtained in this study, for 2000, is based on an estimate of the number of hours worked as calculated by the labour force surveys.
5. See J. Mairesse, G. Cette & Y. Kocoglu (2000), "La mesure de l'investissement en technologies de l'information et de la communication : quelques considérations méthodologiques", *Economie et Statistique*, No 339-340, 9/10.

period (automobiles, clothing, wood-paper etc.) are not the sectors with the highest ICT intensity. Several reasons may explain this observation.

ICT investments are only identified as such when they are isolated (personal computers). IT hardware and software incorporated in other capital equipment - as often occurs when they are used in industry - are not counted as ICT investments (they are recorded in non-ICT investment). The ICT capital intensity of manufacturing industries is therefore likely to be underestimated, while their gains in TFP are overestimated.

ICT heavy user sectors are largely to be found in services (partly because of what has just been said). But it is very hard to measure the productivity of services, especially when their quality changes substantially. Assessments of output in the banking sector, for example, does not take into account improvements in the quality of services, which contrasts to the situation in the United States[6]. TFP gains in this sector may therefore be strongly underestimated in France. Furthermore, adjustments of qualifications to invested capital have been slow in a certain number of sectors, notably in banking. The age structure of the employed population and the number of expected retirees in the future will likely facilitate reorganisation.

Various studies have indeed confirmed the intuition which suggests that for TFP gains to occur, investments in ICT need to be accompanied by company reorganisation[7]. The calculating power of computers cannot raise labour productivity in services indefinitely. The management of human resources, along with the organisation and accompaniment of technological change now have an impact on productivity which is greater than the technical tools applied. However, adapting jobs and skills to the use of ICT may take time and may be slowed down by a more difficult economic outlook. TFP gains linked to ICT are still to be expected in France, in numerous service activities. For France, catching up with the United States is more a question of adapting to technological change than investing in new technology.

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6. See D. Pilat & F.C. Lee (2001), "Productivity Growth in ICT-Producing and ICT-Using Industries: a Source of Growth Differentials in the OECD?", *STI Working Paper* 2001/4, OECD.

7. French Planning Agency (2002), "La France dans l'économie du savoir: pour une dynamique collective", report of the working party chaired by P. Viginier, La Documentation française.

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