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## The North-South Digital Divide in Information and Communication Technologies Development: the Case for Spanish Regions

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**44<sup>th</sup> European Congress of the Regional Science Association**  
**The North-South Digital Divide in Information and Communication**  
**Technologies Development: the Case for Spanish Regions**

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**Abstract**

The "New Economy" is a concept that is associated with the growth of the US economy in the second half of the nineties, which were characterised by high growth in GDP. In attempt to find an explanation for these events, research to date cites the main determinant to be the marked rise in labour productivity that came about as a result of the impact of Information and Communication Technologies, particularly the Internet.

The purpose of the present study is to examine the phenomenon that has arisen around this "new or digital economy" and the development of the Internet from the macro and microeconomic viewpoint and then show how the Spanish regions lag behind the rest of Europe in this respect. Firstly, we present international evidences of the positive impact of ICT in terms of labour and multifactorial productivity in national economies, industrial sectors and firms. These evidences are contrasted with some spanish studies.

Secondly, we measure the importance of ICT in Europe. We base our method on a set of indicators, classified into three areas: infrastructure and size of sector, use of Internet and electronic commerce, and social and economic effects. We then examine the Spanish situation within the context of the rest of Europe, and discover a major north-south digital divide affecting certain areas, along with major interregional disparities.

As far as Internet development is concerned, there are major regional differences. The paper points out the fact that Spain registers the highest standard deviation, in other words, the greatest regional differences, which, reflected in terms of different synthetic/composite indicators. This lag in progress contrasts with Spain's public policies aimed at promoting the Internet.

Nevertheless, Internet development can provide the opportunity to close this gap within the EU. It may, however, increase discrepancies between the regions, by giving regions with higher per capita income an advantage in terms of productivity and competitiveness, unless a determined effort is made to implement actions aimed at developing the information society.

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# **The North-South Digital Divide in Information and Communication Technologies Development: the Case for Spanish Regions\***

## **1. Introduction**

Since the prolonged period of growth in United States GDP that took place in the 1990s, when real GDP rose dramatically, the rate of inflation decreased and unemployment fell to what was considered a natural rate, there is growing body of literature that relates output and productivity growth in the US to the adoption and diffusion of Information and Communication Technologies (ICTs).

From the macroeconomic point of view, recent literature has focused on analysing the role of ICTs in economic growth and productivity trends in OECD countries. Other studies have investigated further into the impact of ICTs at firm level, in order to determine their influence on behaviour in firms, sectors and markets.

Various institutions, both public and private, have directed their efforts towards the creation of indicators to assess the dimensions of the ICT sector in individual countries and thus obtain more accurate international comparisons. Analysis of the range of available indicators has provided further understanding of the major gaps that exist both between countries and regions when it comes to adopting the New Economy.

It is against such a background that this article aims to examine the phenomenon of the New Economy, from the perspective of ICT impact at national, industrial and firm level, with specific attention to the case of Spain. Section 2 contains a review of the main findings in the literature with respect to the impact of ICTs on economic growth and productivity at national, sectoral, and firm level. Section 3 presents the ICT measurement methodology, based on the comparison of the main indicators devised by various organisations both national (Spanish) and

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international. Analysis of the existing indicators in Section 4 provides a picture of the extent of ICT and Internet development in Spain as compared to the rest of Europe.

## **2. The ICT impact in Countries, Industries and Firms**

The effects of ICT on output and productivity growth have been examined extensively, particularly after the well-known productivity paradox of Solow (1987): “*computers can be found everywhere except in the productivity statistics*”. With this famous sentence, the author stressed that investment in computers by US firms from the late 70s had no apparent effect on measured productivity.

The pattern of GDP and productivity growth in the United States in the latter half of the nineties sparked off a debate over the possible end to Solow’s paradox and the role of ICT in economic growth. From 1995 to 2000, labour productivity grew by an annual rate of 3.1%, clearly a much faster pace than it had from 1973-1995 (1.5%). Similarly, GDP grew at a rate of 4.8% between 1995 and 2000, versus 3% in the period from 1973-1995 (Dedrick *et al.*, 2003).

Apart from some of the most recent studies, [such as the demand approach, which focused on the impact of ICTs on consumer welfare (Quah, 2002)] the economic effects of ICTs can be examined at three main levels: national, sectoral, and microeconomic or firm level.

### ***2.1. Country and industrial level analysis***

At the macroeconomic level, the impact of ICTs on growth and productivity manifests itself in various ways. The production of ICT goods and services, for example, contributes directly to increase GDP or GVA in a particular sector of industry and to improvements in aggregate productivity. In addition, however, when used as a factor of production, ICTs generate a range of effects in ICT-using sectors and industries. The use of ICTs in production processes is particularly important; first of all because they help to reduce the price while improving the quality of ICT goods and services, especially IT equipment and software (Jorgenson, 2001), and secondly because of their special characteristics as enabling and general-purpose technologies.

The indirect impact of ICTs when they are used as input to the production process can, in turn, be analysed, in terms of the following effects:

- Effects deriving from investment in ICT, which replaces investment in other capital goods, and the effects of ICT capital deepening on the productivity of other factors of production.
- The spillover effects of technological progress, which bring about improvements in production processes and product quality. These effects are collectively known as Total Factor Productivity (TFP).
- Effects on productivity deriving from improvements in skilled labour, generated by the use of ICT in production processes.

The empirical evidence for the contribution of ICT to economic growth and productivity in the United States during the nineties reveals the following:

- The ICT sector contributed between 41% and 55% to the growth of labour productivity (Oliner and Sichel 2000, Jorgenson and Stiroh 2000, Van Ark *et al.*, 2002).
- Industries with the highest investment in ICT also register the highest increases in labour productivity (Stiroh, 2001, Jorgenson, 2001, Oliner and Sichel, 2002).
- Alongside the ICT-producing industries, ICT-using industries also play a fundamental role in the growth and acceleration of productivity, the service industries making a particularly important contribution to growth (Stiroh, 2002, Triplett and Bosworth, 2002, 2003, Jorgenson, 2003).
- The ICT-producing and ICT-using sectors, contributed 23% and 35% respectively to economic growth (Oliner and Sichel 2000, Jorgenson, 2001).

This impact of ICT on the macroeconomic variables is not exclusive to the US economy, however; it has also taken place, though on a lesser scale, in other OECD countries. (Colecchia and Schreyer, 2002, Van Ark *et al.*, 2002, 2003, Pilat and Lee, 2001, OCDE, 2003, European Commission, 2003a,b).

In Europe, however, there was a significant decline in the productivity growth trend in the latter half of the nineties. In spite of a significant acceleration in the introduction of ICTs that took place between 1998 and 2001, productivity gains were few, and disparities between countries wide. In large European countries, the contribution of ICT capital was a standstill or

slight drop in the rate of economic growth and an actual decline in TFP growth in comparison to the first half of the nineties (Daveri, 2002).

However, productivity growth in Europe, both in terms of capital deepening and TFP growth, is affected not only by weak ICT impact, but also by the negative growth of productivity in other sectors (Daveri, 2001, European Commission, 2003b).

According to recent literature, other factors, apart from the impact of ICT and measurement problems, help to explain the gap Europe and the United States and discrepancies within Europe. Some differentiating factors we might mention are the respective sizes of the ICT-production industries; varying rates of ICT adoption, especially in the service industries where ICT use is intense; variety in the regulations and structural impediments affecting product and labour markets; differences in specific features of organizational structure, strategy and management practices; firm sizes and characteristics; the wide range of technological and institutional obstacles affecting the diffusion of ICT; low investment in complementary infrastructure and lower intensity of ICT use by ICT-using industries and consumers.

Among the main studies that focus on Spain, we should mention McMorrow and Roeger (2001), Pulido (2001), Daveri (2001), Van Ark *et al.*, (2001), Hernando and Nuñez (2002) and Sainz (2002). These reveal that between 1996 and 1999, the contribution of the ICT-producing sectors to economic growth was somewhere between the 9% reported by Van Ark *et al.* (2001), the 11% of Hernando and Nuñez (2002) and the 15.6% of Daveri (2001). ICT accounts also for 25% of labour productivity growth, according to Van Ark *et al.* (2001).

It is worth noting that, in spite of the loss of economic growth, productivity in the USA continued to grow between 2001 and 2002, which shows that the impact of ICTs is not simply a cyclical or conjunctural phenomenon (Jorgenson *et al.*, 2002, Jorgenson, 2003, European Commission, 2003b, OECD, 2003).

## **2.2. Firm level analysis**

The strongest evidence for the impact of ICT use comes from firm-level evidence (Brynjolfsson and Hitt, 1996, Brynjolfsson *et al.*, 2002, Atrostic *et al.*, 2002, Bresnahan *et al.*, 2002, European Commission 2003b, OECD, 2003, Gargallo and Galve, 2003, López *et al.*,

2003, and Dans, 2001). Among the qualitative impacts of introducing IT at firm level we can distinguish, on the one hand, the effects of using IT to automate processes, such as the direct substitution of capital for labour, consistent with capital deepening. The use of IT allows firms to reduce the number of employees or to increase output faster than labour (Dedrick *et al.*, 2003). The labour market is affected by an increasing demand for more highly skilled workers whose average wages are higher.

With regards to the impact of change in the process as a whole, the evidence shows that the use of ICT improves firms' competitiveness because companies are able to increase their market share by becoming leaner than their competitors. The use of ICT may also help firms expand their product ranges, customise the services they offer or respond better to customer demand. At the same time, the introduction of IT improves information within the firm, thus enabling more effective decision-making by workers and managers (OECD, 2003, Dedrick *et al.*, 2003).

All these effects might lead to an overall increase in productivity. However, the benefits of using ICT depend on sector-specific effects and are not found in equal measure in all sectors. Some ICTs are more important in increasing productivity. This is the case of communication network technologies because of the benefits derived from spillover effects (OECD, 2003, Dedrick *et al.*, 2003).

Empirical evidence also demonstrates that use of ICT has a positive impact on firm performance when accompanied by investments in “intangible assets”, such as new organisational processes and structures, worker knowledge and skills, redesigned monitoring and reporting systems and innovative incentive schemes (Bryolfsson *et al.*, 2003).

The Internet and electronic commerce are good examples of how communication network technologies bring about organisational changes in firms and markets. They involve changes in organisational structure (de-localisation, *coopetition*<sup>1</sup> and outsourcing) and in the work process; innovative practices in human resources and industrial relations; new business practices, such as total quality management and business process reengineering; e-business applications, such as

Enterprise Resource Planning (ERP), Supply Chain Management (SCM), and Customer Relationship Management (CRM), and Knowledge Management Solution (KMS) systems.

This creates new opportunities for market access and monopolistic competition. Changes also occur in the value chain (See, for example, Rayport and Sviokla, 1995, Tapscott, 1999, Evans and Berman, 2001 or Jacobides, 2003), where some middlemen are ousted, newcomers are admitted and existing agents are forced to take on new functions. The characteristics of ICT make for easier product differentiation and segmentation, which in turn enables firms to adapt more readily to customer demand.

Finally, another of the most noticeable consequences of the electronic market is greater price transparency and the opportunity to charge lower prices on the Internet than in the traditional market.

### **3. Methodology to assess the dimensions of ICT in the Spanish economy**

#### ***3.1. Measurement problems***

Measurement problems are a cause of major concern for researchers. Accurate measurement of the ICT sector is required if we are to discover the characteristics and dimensions of ICT impact on the economy and make valid comparisons between countries.

Measurement problems include the difficulty of defining and classifying ICT sector activities and discerning between goods, services and information, while rapid innovation and shrinking prices complicate the measurement of output in products that embody the new technology.

Output measurement in the services sector, where most of the IT capital is concentrated, is very difficult, as is the task of measuring changes in intangible product attributes, such as quality and variety in the manufacturing sector (Bosworth and Triplett, 2000). Firm output measurement requires quality-adjusted price data, which is usually unavailable.

On the input side, a considerable challenge faced those attempting to develop quality-adjusted price indices for IT inputs (Dedrick *et al.*, 2003), an issue further complicated by the

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<sup>1</sup> Market phenomenon in which firms may either cooperate or compete, as the situation dictates at



fact that different countries use different statistical methods to develop adjusted price indices, making international comparisons more difficult to obtain. Meanwhile, it has proven very difficult to classify and quantify investment in software.

### ***3.2. Description of the methodology and analysis of the situation in the EU and Spain***

Despite the complexity it involves, considerable progress has recently been made in assessing the dimensions of the New Economy from various perspectives. The large number of measurement proposals currently in existence is a reflection of the variety of objectives pursued and analytical approaches employed. The result is a wide range of indicators devised by different sources, both public and private.

One possible classification of this set of indicators is as follows:

1. Indicators to measure ICT infrastructure and the relevance of the sector within the economy.
2. Indicators to measure Internet activity and electronic commerce.
3. Indicators to detect barriers to the use of ICTs, the Internet and electronic transactions.
4. Indicators to quantify the economic and social effects of the phenomenon.

At European level, within the broad areas of action defined at the Lisbon Council of Europe within the framework of the Lisbon strategy, there are four main measurement categories: technological, industrial, economic and social, which have led to the proposed set of indicators displayed in Table I.

**Table I. Information Society benchmarking indicators from the eEurope 2005 draft list**

A. CITIZENS' ACCESS TO AND USE OF THE INTERNET
A.1 Percentage of households or individuals having access to the Internet at home
A.2- Percentage of individuals regularly using the Internet
B. ENTERPRISES' ACCESS TO AND USE OF THE INTERNET
B.1-Percentage of persons employed using computers connected to the Internet in their normal work routine
C. COST OF INTERNET ACCESS
C.1-Cost of Internet access broken down by frequency of use in hours per month
D. e-GOVERNMENT
D.1- Number of basic public services fully available on-line
E. e-LEARNING
E.1-Number of pupils per computer with Internet connection
F. e-HEALTH
F.1- Percentage of population, (aged 16 and over) using the Internet to seek health information whether for themselves or others
F.2-Percentage of general practitioners using electronic patient records
G. BUYING AND SELLING ON-LINE (ELECTRONIC COMMERCE)
G.1- Percentage of enterprises' total turnover from e-commerce
H. e-BUSINESS READINESS
H.1- A composite indicator of electronic commerce combining a number of indicators of ICT adoption by enterprises (Internet use, employees using a PC at work, percentage of enterprises with Web page...) and the use of ICTs in electronic commerce
I. INTERNET USERS' EXPERIENCE AND USAGE REGARDING ICT SECURITY
I.1-Percentage of individuals with Internet access having encountered security problems
I.2- Percentage of enterprises with Internet access having encountered security problems
J. BROADBAND PENETRATION
J.1- Percentage of enterprises with broadband access
J.2- Percentage of households or individuals with broadband access
J.3- Percentage of public administrations with broadband access

*Source: eEurope 2005: Benchmarking Indicators, Communication made by the Commission to the European Council and European Parliament (COM 2002, 655 final). Brussels.*

The main attempts at national level in Spain have been made by the National Department of Statistics (NDS) and the Spanish Association of IT Firms (SEDISI) in collaboration with the Spanish Ministry of Science and Technology (SMS&T). Table II shows different types of indicators classified according to the four categories mentioned earlier, and provides a brief outline of the different approaches employed.

**Table II. Classification of official indicators used to quantify ICT usage in Spain**

Type of indicator	SEDISI and SMS&T	NDS
<i>ICT Infrastructure and importance of sector</i>	<b>Infrastructure:</b> - Telephones: land lines, mobile, cable <b>Access Terminals:</b> - PC, laptops, PDA, TV, automatic cash dispensers and electronic sales terminals <b>ICT Industry:</b> - Market and expenditure	Economic structure of IT service providers: - Number of firms, jobs, sales figures, G.V.A. <b>IT Availability and general use:</b> - PCs and mobile phones - Internet Servers and users
<i>Internet and electronic commerce activity</i>	<b>Services:</b> - Households with cable and satellite TV - Internet Hosts and users - Web servers, B2B portals, EDI-Web systems <b>Content:</b> - Firms with web sites - Investment in Internet advertising. <b>Uses (1):</b> - Use of land line, mobile, cable services	<b>IT use by citizens, firms and Public Admin.:</b> - Use of PCs and the Internet - Investment and current expenditure - Internet access and content supply - Public IT expenditure - Online health services
<i>Economic and social effects</i>	<b>Uses (2):</b> - Situation in financial services: Transactions via cash dispenser and smart-card, users of online banking. - Educational uses of the Internet: centres, students and teachers connected to the Internet. - Teleworkers per number of employed	<b>Use of IT in education:</b> - PC and Internet in schools and universities <b>IT training and employment:</b> - Training: courses and expenditure. - Job vacancies.

Source: compiled by authors from Sedisi/DMR (2001) and NDS(2002a,b)

#### **4. Measuring ICT adoption in Spain. The North-South divide in the European Union**

Following the methodology summarised in Table I, we estimate how far Spain lags behind other EU member states in Internet development. Table III shows two different types of indicators: a set referring to the importance of ICTs in the economy (groups 1.1 and 1.2 respectively), and another relating to infrastructure, access to and use of the Internet, by individuals, enterprises and Public Administration (groups 2.1 to 2.4 respectively).

**Table III. Internet benchmark indicators for Spain in comparison with EU and USA**

Type	Indicators	USA	EU	SP	GER	DEN	F	UK	IT	IR	SW
1.1	ICT Investment (1980-2000) <sup>(1)</sup> (% non residential Gross Fixed Capital Formation)	31.4	16.9	<b>10.1</b>	19.2	19.1	13.1	22	16.7	14.6	21.6
1.1	ICT Investment (%GDP), 1999 <sup>(1)</sup>	5.3	3.0	<b>2.8</b>	2.7	2.9	2.2	3.4	3.4	1.9	5.3
1.1	%Markets ICT/GDP, 2000 <sup>(2)</sup>	5.9	6.0	<b>6.3</b>	5.7	6.1	6.1	6.5	5.3	4.8	7.4
1.1	ICT use (%GDP), 1999 <sup>(1)</sup>	2.5	2.1	<b>2.0</b>	1.9	1.9	1.9	2.5	2.3	1.2	2.3
1.1	% use ICT goods /Household Consumption, 1999 <sup>(1)</sup>	3.7	3.9	<b>3.4</b>	3.4	3.9	3.5	4	3.8	2.6	4.6
1.2	%Persons employed in ICT sectors /Total employed, 1999 <sup>(1)</sup>	2.4	1.6	<b>1.1</b>	1.5	2.2	1.7	2.0	1.1	unavail.	2.8
1.2	Teleworkers/Total employed, 1999 <sup>(3)</sup>	unavailable	4	<b>2.8</b>	6	10	2.9	7	3.6	4	15
2.1	Broadband Penetration (%), June 2001 <sup>(1)</sup>	3.21	1.27	<b>0.46</b>	0.95	2.32	0.60	0.27	0.44	0.01	4.07
2.1	Homes with PC (%), 2000 <sup>(1)</sup>	51	38.5	<b>30.4</b>	47.3	65	27.7	38	29.4	32.4	59.9
2.1	Mobile telephone subscribers per 100 pop., 2001 <sup>(4)</sup>	45.0	75.9	<b>65.5</b>	68.2	73.8	60.5	77.0	83.9	72.9	79.0
2.2	Internet users per 100 pop., January 2000 <sup>(1)</sup>	18.2	9.9	<b>9.2</b>	17.5	21.3	5.1	12.4	8.6	10.8	23
2.2	Household Internet Penetration, 2000 <sup>(5)</sup>	unavail.	42.6	<b>31</b>	46	67	36	50	35	57	66
2.2	Internet Servers per 1000 pop. 2001 <sup>(1)</sup>	275.2	53.0	<b>26.2</b>	50.3	98.5	27.2	69.7	40.4	34.6	177.0
2.2	Websites per 1000 pop., June 2000 <sup>(1)</sup>	46.5	12.7	<b>3</b>	22	21	4.3	24.2	6.1	3.3	19.3
2.2	Average price 20 hours access to the Internet 1995-2000. PPP dollars <sup>(1)</sup>	31.7	59.8	<b>78.3</b>	64.6	54.2	54.1	49.7	48.8	78.8	36.9
2.3	Workers using PC at work, 2000 <sup>(6)</sup>	95	60.7	<b>42.6</b>	57	unavail.	67	65	72	unavail.	unavail.
2.4	Availability of on-line government services, 2002 <sup>(7)</sup>	unavail.	56.7	<b>58</b>	46	69	61	63	51	85	81

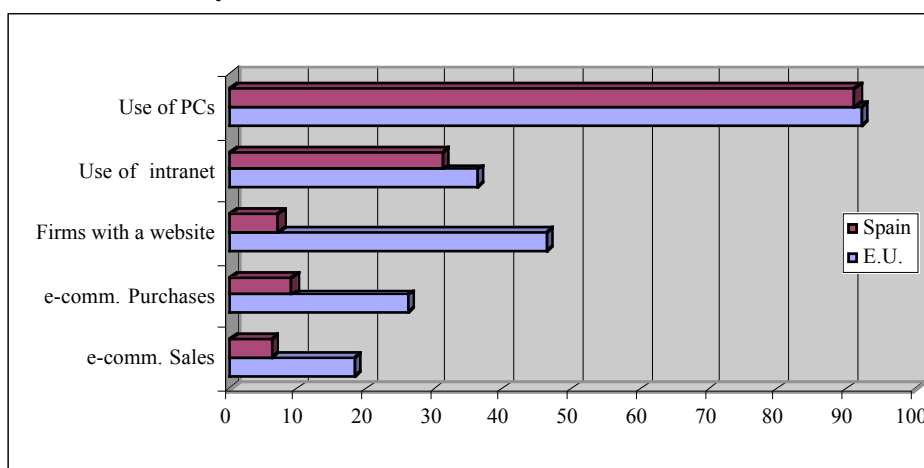
Source: compiled by the authors from <sup>(1)</sup> OECD (2002), <sup>(2)</sup> EITO and EUROSTAT (2001), <sup>(3)</sup> EcaTT (2001), <sup>(4)</sup> ITU (2002), <sup>(5)</sup> European Commission (2002a), <sup>(6)</sup> Department of Trade and Industry, United Kingdom (2001) and Sedisi/DMR (2001) for Spain, <sup>(7)</sup> C.E./Cap Gemini Ernst & Young (2002). \* Only for the EU. (11).

Spain is well behind other European countries in investment and employment in ICTs, though the picture improves slightly if we consider the market and consumer indicators as a percentage of GDP. Broadly speaking, Spain is close to Italy and Ireland, while lagging well behind Sweden, Denmark and Germany. With regards to the Internet, a gap continues to

separate Spain from the European average, not only in infrastructure, but also in ICT activity in households and firms. Spain, with Ireland, has the highest Internet access charges in Europe. The only notable exception to the overall picture is a good level of Internet use by the Public Administration.

The situation is little better when electronic commerce in Spanish firms is compared with the European average (Figure 1). In Spain there is less use of electronic commerce both in buying and selling; the main barriers to their usage being lack of security on the web, followed by high access costs.

**Figure 1. Spain. Main indicators of electronic commerce in firms. (% firms). February 2001**



*Source: EUROSTAT (2002).*

In classifications of countries according to the various global indices for the Information Society in the year 2002, Spain appears well behind the main developed countries, and ahead only of Portugal and Greece within the context of the EU (CID, 2002).

With regards to the situation of the European regions, we again notice evidence of this north-south divide. To obtain a clearer view of the situation, it is worth examining the Regional Innovation Scoreboard (RIS) This indicator includes three composite indicators of which the most important is the Revealed Regional Summary Innovation Index (RRSI), which uses data on thirteen different regional indicators to define the situation in each region as compared to the

rest of its own country and to the European average according to the NUTS2 and 1 classification.<sup>2</sup>

Table IV summarises the national scores compiled from the regional data, and lists countries in three groups: leaders, followers, and slow adopters in the Information Society, each group separated by a thicker line. Note that the slowest group includes most of the countries of Southern Europe.

Also included are some indicators of inequality in regional innovation, based on conventional parameters, such as standard deviation, the coefficient of variation, and the Gini and Theil coefficients, in both of which regional data are weighted by regional population, according to the 2003 population forecasts reported by Cambridge Econometrics.

The Gini coefficient is calculated as follows:

$$G = 1 - \frac{1}{n} \sum \frac{f_i}{f} (s_{i-1} + s_i); \text{ where } \frac{f_i}{f} \text{ is the weighting coefficient, expressed by the}$$

regional/national population in 2003, and  $s_i$  is the RRSII score for the region.

The Theil coefficient is calculated as follows:

$$G_1 = \frac{1}{n} \sum \frac{f_i}{f} \frac{x_i}{\bar{x}} \ln \frac{x_i}{\bar{x}}; \text{ where } \frac{f_i}{f} \text{ is the weighting coefficient, expressed by the}$$

regional/national population in 2003,  $x_i$  is the RRSII score for the region, and  $\bar{x}$  is the national RRSII median.

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<sup>2</sup> These are the following indicators: (1) population with tertiary education, (2) lifelong learning, (3) employment in medium/high-tech manufacturing, (4) employment in high tech services, (5) public R&D expenditures, (6) business R&D expenditures, (7) EPO high-tech patent applications, (8) all EPO patent applications, (9) and (10) the share of innovative enterprises in both manufacturing and services, (11) and (12) innovation expenditures as a percentage of turnover in both manufacturing and services, and (13) the share of sales of new-to-the-firm products in manufacturing. Per capita GDP at the regional level for the EU member states is also used

**Table IV. RRSII 2003 Ranking of EU countries and regional inequality measures**

Countries	Mean score	Median	Mode	Standard Deviation	Coefficient of Variation	Gini Coefficient	Theil Coefficient
European Union	0,3775	0,34	0,19	0,2134	0,5652	0,2970	0,1397
Sweden	0,5175	0,505	0,26	0,2899	0,5602	0,2098	0,08719
Finland	0,5050	0,475	0,17	0,2768	0,5482	0,1959	0,0650
Belgium	0,4667	0,52	0,17	0,2739	0,5870	0,2196	0,1076
United Kingdom	0,4667	0,41	0,35	0,1949	0,4177	0,2063	0,0685
Holland	0,4483	0,445	0,14	0,2144	0,4783	0,1940	0,0731
Ireland	0,4450	0,445	0,15	0,4172	0,9375	0,1958	0,1279
Germany	0,4418	0,395	0,34	0,1932	0,4374	0,2369	0,0895
Austria	0,3767	0,39	0,41	0,1827	0,4850	0,2367	0,0978
Italy	0,3385	0,32	0,17	0,1967	0,5812	0,3087	0,1666
France	0,3078	0,27	0,23	0,1683	0,5467	0,2859	0,1315
Spain	0,3044	0,265	0,19	0,1909	0,6270	0,3164	0,1622
Portugal	0,2271	0,23	0,03	0,1979	0,8712	0,2763	0,1436
Greece	0,2062	0,17	0,1	0,1544	0,7490	0,3260	0,1856

*Source: Compiled by the authors from regional data supplied by the European Commission (2003c) and the Cambridge Econometrics database, using SPSS 11.2 and INEQ software. Data are not presented for Luxembourg, a country formed by a single region, where inequality indicators do not, therefore, apply.*

In innovative performance also, there are major regional differences in Spain. On the whole, national innovation capabilities tend to be concentrated in a few regions, with the slow adopters registering the highest inequalities. Among them, Spain and Greece present the greatest regional differences. Spanish regions with higher GDP per capita and the northern regions register the highest degrees of penetration at regional level. At the other extreme, there are 12 Spanish regions, with a very low level of Internet usage (the south and rural regions and the islands).

The Spanish Government, aware of the country's developmental lag with respect to the Internet, has put certain specific plans into action. The most recent is the "Plan España.es" (2003-2005) which is aimed at encouraging demand among the population for access to the new technologies; improving infrastructure, content and services to encourage take-up, and promoting the use of ICT in small and medium enterprises (SMEs).

## 5. Conclusions

The digital economy is a complex and emerging phenomenon, with effects at both macro and microeconomic level. A number of studies have documented the significant impact of ICT investment on the productivity of firms, industries and countries during the second half of the 90s and the process appears set to continue into the future. The earlier productivity paradox theory therefore appears to have been refuted.

Nevertheless, there are significant differences between countries and between firms. In addition to the differences relating to ICT take-up, there are other factors to account for Europe's lag behind the USA: differences in market regulation, financial market structure, or amount invested in knowledge. The wide range of performance between different organisations with regard to ICT investment can also be explained by complementary investments in organisational capital, new business styles and firm characteristics. Despite the important role played by ICT in economic growth, ICT investments will not yield their full potential in productivity benefits, unless they are accompanied by investment and changes in other areas.

Further research is needed to solve measurement problems in order to obtain an accurate assessment of the impact of ICTs. This means creating valid, internationally comparable, indicators. In spite of the difficulties involved in devising suitable indicators, a great number have already been introduced by a variety of organizations. Existing indicators can be classified into three broad categories: ICT infrastructure and market indicators; indicators of access to and use of ICTs; and indicators that measure the social and economic effects.

In spite of the considerable progress made to date in the penetration of the new economy in Spain, the country stills remains below the European average. This provides some explanation for the lower impact of ICTs in Spanish economic growth, when compared to the rest of Europe.

Support policies are needed in order to improve ICT adoption in southern European countries. Initiatives should be aimed chiefly at:



- Encouraging Internet use by households and small firms, especially in the services sector.
- Promoting investment in human capital.
- Designing public policies to reduce the burden of regulation, introduce more flexibility in markets, and remove barriers to innovation and the creation of new businesses.

Further research is needed to determine the causes of regional disparities in ICT development. Special attention should clearly be paid to the analysis of intangible assets and regional policies to account for existing differences.

## 6. References

- Atrostic, B.K., Boehg-Nielsen, P. and Motohashi, K. (2002), IT, Productivity and Growth in Enterprises: Evidence from New International Micro Data, paper presented at OECD Workshop on ICT and Business Performance, Paris.
- Banegas, J. (2001) "Effects of Information and Communication Technologies on day-to-day business", *Revista del Instituto de Estudios Económicos*, No 1-2, pp. 415-440. (In Spanish)
- Bosworth, B.B. and Triplett, J.E. (2000), What's new about the new economy? IT, economic growth and productivity, Working Paper, Brookings Institution, Washington.
- Bresnahan, T. F., Brynjolfsson, E. And Hitt, L.M. (2002) "Information Technology, workplace organization and the demand for skilled labour. Firm-level evidence", *Quarterly Journal of Economics*, Vol 117 No 1, pp. 339-376.
- Brynjolfsson, E., Hitt, L.M. and Yang, S. (2002), Intangible Assets: Computers and Organizational Capital, *Brookings Papers on Economic Activity: Macroeconomics*, Vol. 1, pp. 137-199.
- Brynjolfsson, E. and Hitt, L.M. (1996) "Paradox Lost? Firm-level Evidence on the Returns to Information Systems Spending", *Management Science*, Vol. 42 No 4, pp. 541-558.
- CID. Center for International Development (2002), *The Global Information Technology Report 2001-2002: Readiness for the Networked World*, University of Harvard, Harvard.

- Colecchia, A. and Schreyer, P. (2002), The Contribution of Information and Communication Technologies to Economic Growth in Nine OECD Countries. OECD Economic Studies, No 34, 2002/1, Paris.
- Dans, E. (2001) "IT Investment in small and medium enterprises: paradoxically productive?", The Electronic Journal of Information Systems Evaluation, Vol. 4, pp. 1-9. Available <http://www.iteva.rug.nl/ejise/>
- Daveri, F. (2001), Information Technology and Growth in Europe, University of Parma and IGIER, mimeographed.
- Daveri, F. (2002) "The New Economy in Europe, 1992-2001", Oxford Review of Economic Policy, Vol. 18 No 3, pp. 345-362.
- Dedrick, J., Gurbaxani, V. and Kraemer, K.L. (2003), Information Technology and Economic Performance: a Critical Review of the Empirical Evidence, University of California, Working Paper.
- Department of Trade & Industry U.K. (2001), Business in the Information Age. International Benchmarking Study 2000, London.
- EcaTT. Electronic Commerce and Telework Trends (2001), Benchmark Progress in Electronic Commerce and New Methods of Work, European Commission, Brussels.
- EITO. European Information Technology Observatory (2001), Frankfurt.
- European Commission (2002a), Eurobarometer November 2002, Brussels.
- European Commission (2003a), The EU Economy: 2003 Review, Directorate General Economic and Financial Affairs, Brussels.
- European Commission (2003b), European Competitiveness Report 2003, Commission Staff Working Document, Brussels.
- European Commission (2003c), 2002 European Innovation Scoreboard: Technical Paper No 3 EU Regions, Brussels.
- Eurostat (2001), Statistical Indicators for the new economy (SINE), Brussels.
- Eurostat (2002), E-commerce in Europe. Results of the pilot surveys carried out in 2001, Brussels.

- Evans, J.R. and Berman, B. (2001) "Conceptualizing and Operationalizing the Business-to-Business Value Chain", *Industrial Marketing Management*, Vol. 30 No 2, pp- 135-148.
- Gargallo, A. and Galve, C. (2003), *The Impact of Information Technologies on productivity: analysis of the Spanish case*. ACEDE Congress, Mallorca, Spain. (In Spanish)
- ITU. International Telecommunication Union (2002): *Indicators*, Geneva. (In Spanish)
- Jacobides, M.G. (2003), *How do Value Chains Break-up & Markets Emerge?*, Conference on Digital Transformations: ICT's Impact on Productivity, London Business School, London.
- Jorgenson, D.W. (2003), *Information Technology and the G7 Economies*, Conference on Digital Transformations: ICT's Impact on Productivity, London Business School, London.
- Jorgenson, D.W. (2001) "Information technology and the US economy", *American Economic Review*, Vol 91 No 1, pp.1-32.
- Jorgenson, D.W. and Stiroh, K.J. (2000) "US Economic Growth in the New Millennium", *Brooking Papers on Economic Activity*, No 1, pp. 125-211.
- Jorgenson, D.W., Ho, M.S. and Stiroh, K.J. (2002) "Projecting Productivity Growth: Lesson from the US Growth Resurgence", *Federal Reserve Bank of Atlanta Economic Review*, third quarter, pp. 1-13.
- López, J.I., Minguela, B., Rodríguez, A. and Sandulli, F. (2003), *Internet usage and the productivity paradox: the case of Spanish firms*, ACEDE Congress, Mallorca, Spain. (In Spanish)
- Morrow, K. Mc. and Roeger, W. P. (2001), *Potential Output: Measurement Methods, "New" Economy Influences and Scenarios For 2001-2010. A Comparison of the EU-15 and the US*, European Commission.
- NTS, National Department of Statistics (2002a), *Survey on the use of ICT and e-commerce in firms*, Madrid. (In Spanish)
- NTS (2002b), *Survey on information technologies in the home*, Madrid. (In Spanish)
- OECD (2002), *Measuring the Information Economy*, Paris.
- OECD (2003), *ICT and Economic Growth. Evidence from OECD countries, industries and firms*, Paris.

- Oliner, S.D. and Sichel, D.E. (2000) "The Resurgence of Growth in the Late 1990's: Is Information Technology the Story?", *Journal of Economic Perspectives*, Vol 4 No 14, pp. 3-22.
- Oliner, S.D. and Sichel, D.E. (2002) "Information technology and productivity: where are we now and where are we going?", *Economic Review*, Vol. 3 No 3, pp. 15-41.
- Pilat, F. and Lee, F.C. (2001), *Productivity Growth in ICT-Producing and ICT-Using Industries: A Source of Growth Differentials in the OECD? STI Working Papers 2001/4*, OECD, Paris.
- Pulido, A. (2001) "The New Economy: assessing the impact", *Revista de Información Comercial Española*, No 793, pp. 17-23. (In Spanish)
- Quah, D. (2002), *Technology Dissemination and Economic Growth: Some Lessons for the New Economy*, LSE, CEP/Discussion Paper 0522, London.
- Rayport, J. and Sviokla, J. (1995) "Exploiting the virtual value chain", *Harvard Business Review*, Vol. 73 No 6, pp. 79-82.
- Sainz, J. (2002), *The New Economy in Spain: the impact on growth and financial markets*. Doctoral Thesis, King Juan Carlos I University. (In Spanish)
- SEDISI/DMR (2001), *Information Society Metrics in Spain*, Sedisi, Madrid.
- Scarpetta, S. and Tressel, T. (2002), *Productivity and convergence in a panel of OECD industries: Do regulations and institutions matter? OECD Economic working papers 2002/28*, Paris.
- Stiroh, K.J. (2002) "Information Technology and the U.S. Productivity Revival: What do the Industry data say?", *American Economic Review*, Vol. 92 No 5, pp. 1559-1576.
- Tapscott, D. (1999), *Creating value in the network economy*. Harvard Business School Press, Boston.
- Triplett, J.E. and Bosworth, B.B. (2003), *Services Productivity in the United States*, Conference on Digital Transformations: ICT's Impact on Productivity, London Business School, London.

- Triplett, J.E. and Bosworth, B.B. (2002), Baumol's Disease Has Been Cured: IT and Multifactor Productivity in US Services Industries, paper prepared for Brookings Workshop on Services Industry Productivity, Brookings Institution, Washington DC.
- Van Ark, B. (2001), The Renewal of the old economy: an international comparative perspective, STI Working Paper 2001/5, OECD, Paris.
- Van Ark, B., Inklaar, R. and McGuckin, R. (2002), Changing Gear. Productivity, ICT and Services Industries: Europe and the United States, Groningen Growth and Development Centre, Working Paper, Groningen.
- Van Ark, B., Melka, J., Mulder, N., Timmer, M. and Ypma, G. (2003), ICT Investments and Growth Accounts for the European Union 1980-2000, Groningen Growth and Development Centre, Groningen.