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The Role of ICT in the Economic Growth and Productivity of Andalucia

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Preface

The importance of knowledge, innovation and ongoing technological changes linked to the advent of information and communication technologies (ICT) have engendered intense public discussions over the past few years. In particular, there is increasing awareness of the fact that these elements strongly determine the way our economies and societies keep pace with, and possibly benefit from, the globalization process. These questions raise important prospective issues of strong relevance for the European Union.

From a regional perspective, in particular, it is important to know whether these changes have any impact in terms of economic development and innovation dynamics differentials across EU regions. The diffusion of ICT across the EU economy appears to be a major lever for improving both productivity levels and competitiveness, while encouraging the re-organisation of production methods and the emergence of new activities. Existing empirical evidence is still, to a large extent, only available at country level. However, there is an increasing awareness of the need to adopt, together with country-level initiatives, regional policies. Given the fact that on-going technological change and innovation dynamics have a strong local/regional component, public policies need to be designed at this level as well.

The ICT Unit, IPTS has set out to investigate these issues through a number of ongoing research projects and other scientific activities. This specific research activity aims to contribute to the IPTS mission to provide customer-driven support to EU policy-making processes by providing research-based analysis of questions related to ICT diffusion, knowledge and innovation in EU regions. The objective of the present study undertaken by Jesus Rodriguez (Universidad Pablo de Olavide) and Diego Martínez (Universidad Pablo de Olavide and Centro de Estudios Andaluces) and coordinated by Elena Navajas (DG JRC, IPTS) and Salvador Barrios (DG JRC, IPTS) is to measure ICT adoption in the Andalusian economy and to assess the contribution of these technologies to economic and productivity growth in this region.

The topic of this research is highly relevant as, on the one hand, empirical evidence at the regional level is scant and, on the other hand, the policy issues are at the core of the EU policy agenda. This study must be seen as a first step towards a regional approach to analysing the contribution of ICT to productivity and economic growth. The data and methodology used in the study are consistent with existing country-level studies and thus provide a useful starting point for further research addressing the impact of ICT in other EU regions.

TABLE OF CONTENTS

Executive Summary

The recent experiences of the US and some European countries show that ICT investment promotes economic growth and labour productivity. However, the European Union as a whole is still lagging behind the US in terms of ICT contribution to productivity. The review and re-launching of the Lisbon Strategy in 2004 has put special emphasis on the Information and Communication Technologies (ICT) as a means of meeting the challenges of boosting growth, competitiveness and cohesion throughout Europe. In particular, in July 2005, the European Commission adopted the initiative i2010: European Information Society 2010, which stressed the importance of this issue in the following terms "Information and Communication Technologies are a powerful driver of growth and employment. A quarter of EU GDP growth and 40% of productivity growth are due to ICT. Differences in economic performance between industrialised countries are largely explained by their levels of ICT investment, research, and use, and by the competitiveness of their Information Societies". These objectives will largely influence the EU economic policy agenda in the coming years and have already translated into concrete policy proposals that favour structural and technological changes across the EU. Furthermore, the assessment made by the European Commission on the National Reform Programmes also shows that ICT usually rank high in measures taken by the Member States. Moreover, in the context of cohesion policy, public support is increasingly being used to accelerate deployment and use of ICT in the less developed areas of the Union. European research policy is also directly concerned by these questions: the objectives of ICT research under the EU's Seventh Framework Programme (FP7) endorse the promotion of ICT for boosting productivity and innovation, the modernisation of public services and direct support to research to develop applications linked to ICT. A number of initiatives, such as the "Regions of Knowledge", have also tended to reinforce the EU emphasis on the need to adopt a regional approach to research policy.

Such a growing number of EU policy initiatives, including the i2010 objectives, calls for a better understanding of the way ICT might favour knowledge and innovation diffusion and the emergence of new types of economic activities. From a research viewpoint, it has been largely documented that innovation activity is even more geographically concentrated than industrial activity. Increasingly, the ongoing transformations and structural/technological

changes enabled by ICT are being studied by region, and more specifically, as part of regional innovation systems. In particular, the technological changes propitiated by ICT already affect the geographical location of industries and productivity differentials across EU regions. ICT also generate positive side-effects on the innovative capability through learning-by-doing and transfer of know-how. There is an increasing awareness of the need to adopt, together with country-level initiatives, regional policies given that the nature of ongoing technological change and innovation dynamics have a strong local/regional component, hence public policies need to be designed at this level as well. Little is yet known, however, about the consequences of the advent of ICT use on regional economies.

In order to effectively build policies addressing the needs and challenges posed by the advent of the so-called knowledge economy, it is necessary to develop analytical tools and to gather relevant data to better understand the role ICT may play in economic growth and, particularly, with regard to regional development and innovation dynamics differentials across EU regions. The existing evidence on the diffusion and impact of ICT across EU regions is still scant. The few existing studies on EU regions have shown that the situation of the Member States and the European regions with respect to ICT take-up vary widely.1

This report is the final delivery of a project launched by IPTS in order to explore the possibilities, advantages and drawbacks offered by current well-developed methodologies and available data at regional level, in order to assess specific aspects of the impact of ICT with regional scope. This study analyses the contribution of ICT investment to productivity growth by means of growth accounting, adopting the theoretical framework first formulated by Solow (1957) and further developed by Griliches and Jorgenson (1967) and Jorgenson (2001). The measurement of productivity has long been associated to objectives other than the sole calculation of value added per hour worked in order to assess the relative prosperity of national economies. In this sense, there is an ongoing debate as to what extent this methodology may also illustrate how innovation (usually referred to under the broader term technical change) spreads across a given economic system and how it links to economic growth. Several mechanisms play a role in making technological progress a source of growth – new materials, products and processes, technologies that allow for efficiency gains or alter how producing factors relate among them (labour-capital ratio or the so-called factor substitution, organisational changes, etc.), learning effects…- in short, everything ranging

[1] See ESPON (2005), Telecommunication Services and Networks: Territorial Trends and Basic Supply of Infrastructure for Territorial Cohesion,Project 1.2.2, Final report available at: www.espon.lu and Koski, H.,

from improvements in a strict engineering sense to economic efficiency gains. However, growth accounting is a limited tool as regards to how these mechanisms contribute to productivity growth. This drawback arises, partly, from the theoretical assumptions needed in order to construct the model by which productivity is measured (i.e. the production function), and which involve evaluating the joint contribution of all factors mentioned above as a residual, as pointed out by Solow in his famous remark, "the measurement of our ignorance". Notwithstanding these limitations, nowadays growth accounting stands as the most effective tool to explore in a standard and, thus, comparable way, the direct contribution to growth of labour, capital, and technology, leaving aside the discussion on how technology (meant as a broad concept here) translates into growth. Obviously, investment in ICT alone does not bring the positive effects associated with the new technologies. Still, capital accumulation in ICT assets might bring insights into ICT diffusion and the potential for growth it offers.

Growth accounting has traditionally been applied at country-level. A distinctive feature of the present study, however, is that it applies the growth accounting framework to a regional case study, namely the Spanish region Andalucía, and must be seen as a first attempt at regional analysis.2 The use of the growth accounting framework to analyse the impact of ICT on productivity and growth must then be seen as a basic starting point for analysing these issues at the regional level. A clear advantage of this methodology is that it allows comparisons of productivity patterns between regions which have adopted ICT unevenly and, therefore, are also less likely to benefit equally from the potential offered by the knowledge-based economy. The methodology and theoretical framework used here are described in Section 2 of the Report.

Section 3 reviews existing international evidence for a set of OECD countries. In particular, the results show that Spain is still lagging behind in terms of ICT impact on productivity and growth.

Sections 4 to 6 explore the contribution of ICT to the growth of the economy and labour productivity of Andalucía over the period 1995-2004. The analysis takes into account the structural factors specific to the Andalusian economy. Andalucía is a large Spanish region representing 17% of the national population and contributing 14% to the national Gross Domestic Product (GDP). The Andalusian economy has long been dominated by the agricultural sector. However, the service sector also represents a relevant share of the overall

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P. Rouvinen and P. Ylä-Anttila, (2002), ICT clusters in Europe: The Great central Banana and the Small Nordic Potato, Information Economics and Policy 14: 145-165.

economy, explained mainly by the fact that the region is a prominent tourist destination. Moreover, the relative weight of non-market services (public administration, education, health) within the service sector is more significant in the Andalusian economy than in the rest of Spain. Considering all this, it is interesting to analyse how ICT investment is spread among the different sectors of the economy and to what extent it contributes to the productivity growth of the overall economy of the region. ICT assets have been classified into three items (Hardware, Software and Communication Equipment), according to the OECD (2002), and the ICT user sectors have also been selected according to the taxonomy recommended by the OECD (Energy & Water, Pulp, paper, printing & publishing, Electric, electronic & optic equipment, Transport and communications, Financial intermediation, Business services, Private health & social services, Other community, social & personal services).

The main results of the study are outlined in **Section 7.**

- *First*, Spain stands among the least intensive ICT-user countries within the EU-15 area, a result which is consistent with previous studies. In turn, Andalucía is a less intensive user than Spain as a whole, but it is steadily converging towards the Spanish average.
- *Second*, the contribution of ICT assets to industrial production outcome (measured as total market Gross Value Added (GVA) growth) is quantitatively modest but high in relative terms, especially when the proportion of ICT investment over the total expenditure incurred by companies in the production process is considered. In this sense, it can be concluded that the potential for a higher contribution of ICT capital to productivity growth is still significant.
- *Third*, growth rates and levels of labour productivity are remarkably higher in the Andalusian intensive ICT user sectors, further reinforcing the previous assertion.
- *Fourth*, the contribution of ICT investment to GVA and employment growth within the intensive ICT user sectors has experienced a considerable increase.
- *Fifth*, the study shows that, in the case of the few intensive ICT using *service* sectors, ICT assets do have an important contribution to both GVA growth and productivity growth (Ex.: Financial intermediation, Business services, etc.).

[2] See, in particular, Jorgenson, D. (2001) "Information Technology and the U.S. Economy," *American Economic Review*, Vol. 90, No. 1, March 2001, pp. 1-32;

- *Finally*, the main conclusion of the study is that while the contribution of ICT to GVA and productivity growth in Andalucía is noticeable, the advantages related to ICT diffusion have not yet reached their full potential.

From a policy viewpoint, these results show that ICT can be seen as a lever for long-term productivity growth. Furthermore, given the very specific case-study considered here, the results show that the contribution of ICT to regional growth is tied to the existing conditions and structures of the Andalusian economy. In this sense, policies need to a large extent to be tailored according to regional-specific features. For instance, an important question concerns the identification of the main variables to speed up the diffusion of ICT and their corresponding expected effects. Adoption costs also are an important factor delaying the implementation of ICT in a given region. Given the potential positive impact of ICT on regional economies as evidenced in the present study, it is very important to identify the determinants of ICT adoption and to assess the way regional policy can help reduce potential barriers to ICT adoption. More generally, these results also show that the regional dimension of ICT contribution to productivity growth is worth considering as substantial differences may arise which could influence the long-term convergence of EU regions lagging behind. Future studies, as the one developed here for the case of Andalucía, could therefore be carried out for other EU regions in order to assess to what extent and under which conditions technological change has a favourable economic influence on regional development across the EU.

Introduction

In March 2000, European leaders committed the European Union to becoming, by 2010, the most dynamic and competitive knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion, and respect for the environment (Kok, 2004). To achieve this goal, they adopted what was called the *Lisbon Strategy*. In spite of the disappointing performance of European Union and its Member States in pursuing the Lisbon objectives, several recent reports and Commission documents have reaffirmed the importance of the Lisbon strategy, emphasizing the role of the information society technologies in creating growth and competitiveness in Europe (see, for instance, Price Waterhouse-Coopers, 2004).

Accordingly, the review and re-launching of the Lisbon Strategy in 2004 put special emphasis on the Information and Communication Technologies (ICT) as a means of meeting the challenges of boosting growth, competitiveness and cohesion throughout Europe. In addition, the European Commission adopted the initiative *i2010: European Information Society 2010* in July 2005, stressing the importance of this issue in the following terms "Information and Communication Technologies are a powerful driver of growth and employment. A quarter of EU GDP growth and 40% of productivity growth are due to ICT. Differences in economic performance between industrialised countries are largely explained by their levels of ICT investment, research, and use, and by the competitiveness of their Information Societies" (See http://europa.eu.int/information_society/eeurope/i2010/index_en.htm).

These objectives will largely influence the EU economic policy agenda in the coming years and have already translated into concrete policy proposals to favour structural and technological changes across the EU. The assessment made by the European Commission on the National Reform Programmes also show that ICT usually rank high in measures taken by the Member States together with increases in R&D expenditure, and measures favouring the development of innovation poles and SME networking (European Commission, 2006a). Furthermore, in the context of the cohesion policy, public support is increasingly being used to accelerate deployment and use of ICT in the less developed areas of the Union, see European Commission (2006b). European research policy is also directly concerned by these questions as shown by the ICT research objectives in the EU's Seventh Framework

Programme (FP7). These involve the promotion of ICT to boost productivity and innovation, the modernisation of public services, and giving direct support to research to develop applications linked to ICT. A number of initiatives such as the "Regions of Knowledge" have also tended to reinforce EU emphasis on the need to adopt a regional approach to research policy.

The growing number of EU policy initiatives that have included the i-2010 objectives calls for a better understanding of the way ICT favour knowledge and innovation diffusion and the emergence of new types of economic activities. From a research viewpoint, it has been widely documented that innovation activity is even more geographically concentrated than industrial activity; many have claimed that knowledge and technological spillovers are sharply reduced with distance[3]. Increasingly, the ongoing transformations and structural/technological changes enabled by ICT are being studied by region, and more specifically, as part of regional innovation systems. Still little is known, however, about the consequences of the advent of ICT use on regional economies In particular, the technological change propitiated by ICT is already affecting the geographical location of industries and productivity differentials across EU regions. Existing empirical evidence shows that territorial agglomeration provide the best context for an innovation-based economy promoting localised learning and endogenous regional economic development.

There is increasing awareness of the fact that these elements strongly determine the way our economies and societies keep pace with, and possibly benefit from, the globalization process. These questions raise important prospective issues of direct relevance for the European Union. From a regional perspective, in particular, it is important to know whether these changes have any impact in terms of economic development and innovation dynamics differentials across EU regions. The dissemination of ICT across the EU economy appears to be a major lever for improving both productivity levels and competitiveness, and also encouraging the re-organization of production methods and the emergence of new activities. ICT also generate positive side-effects on the innovative capability through learning-by-doing and transfer of know-how. There is also an increasing awareness of the need to adopt, together with country-level initiatives, regional policies given that the nature of ongoing technological change and innovation dynamics have a strong local/regional component. Public policies need to be designed at this level as well.

[3] See, in particular, Fujita, M. and J. F. Thisse, (2002).

The situation of the Member States and the European regions with respect to ICT take-up vary widely [see ESPON (2005) and Koski et al. (2002)]. In order to effectively build policies addressing the needs and challenges posed by the advent of the so-called knowledge economy, it is necessary to develop tools and to gather relevant data to better understand the role ICT may play in economic growth and, particularly, in regional development. The work presented here focuses on the contribution of ICT investment to productivity growth using a growth accounting framework. The basic starting point of this methodology takes is rooted in the seminal work of Solow (1957), who introduced technological progress as a major source of economic growth, instead of attributing it exclusively to capital accumulation. Solow applied the growth accounting framework to disaggregate the contribution of so-called technological change from the relative shares of capital and labour. Since Solow's contribution, economic growth theories have focused on the identification of the sources of technological progress and technology dissemination, which are now unanimously seen as the ultimate source of long-term economic growth [see Barro and Sala-i-Martin (1995)]. In particular, economic analysis has shifted towards elements such as human capital (education and training), R&D and technology diffusion which could be used to increase both growth potential and productivity levels. The use of the growth accounting framework to analyze the impact of ICT on productivity and growth must then be seen as a basic starting point for analyzing these issues at the regional level. A clear advantage of this methodology is that it allows comparisons of productivity dynamics between regions which are unevenly adopting ICT and, therefore, are also less likely to equally benefit from the potential offered by the knowledge-based economy. Furthermore, as suggested above, technology adoption, knowledge spillovers and innovation all have a strong local/regional dimension, hence public policies need to be designed at this level as well. Important policy issues are at stake, in particular, the potential impact of ICT diffusion on regional cohesion within the EU.

This study explores the contribution of ICT on economic growth and labour productivity growth of Andalucía over the period 1995-2004. Andalucía is a southern Spanish region that counts for 17% of the national population, contributing in 14% to the national Gross Domestic Product (GDP). The Andalusian economy has traditionally been agriculture-based. However, the service sector also represents a relevant share of the overall economy, explained mainly by the fact that the region is an important tourist destination. Moreover, the relative weight of non-market services (public administration, education, health) within the service sector is more significant in the Andalusian economy than in the Spanish one. Bearing this in mind, it is interesting to study how ICT investment affects the different sectors of the economy within the local economic structure. To date, no study has dealt with growth accounting at the regional level. Here, ICT are considered as a capital input disaggregated into three items: communication, hardware and software, using the series constructed in Mas, Pérez and Uriel (2003 and 2005a) and Mas and Quesada (2005a). Non-ICT capital inputs are also broken down into three items: building and construction, machinery and other equipment, and transport equipment. Using these assets and those of labour inputs, the present study develops a growth accounting exercise in order to identify the contribution of each type of capital to economic and labour productivity growth. It should be noted here that the methodology that is followed is consistent with recent recommendations by the OECD (2001a and b), regarding this kind of study. The results are also compared with those obtained at Spanish national level by Mas and Quesada (2005, 2006). The period considered spans 1995 to 2004, from which we have a consistent data set on regional accounts disaggregated into 25 market economy sectors (agriculture, cattle farming and fishing sector included). This period also represents the longest expansion in the history of business cycles in Spain. We borrow from Mas and Quesada (2006) their typology that classifies sectors according to ICT-use intensity. Eight sectors are identified as specially ICT intensive. The main results are as follows. *First*, Spain appears as one of the least intensive ICT users within the EU-15 area, a result which is line with previous studies by Timmer, Ypma and van Ark (2003) and Daveri (2000). In turn, the ICT intensity level in Andalucía is lower than the national level, although it is steadily converging towards the Spanish average (IEA, 2002-2004). *Second*, the contribution of ICT assets to total market Gross Value Added (GVA) growth is quantitatively modest but higher than their cost shares. *Third*, although the share in GVA and employment generation has remained apparently constant during the period 1995-2004, the contribution to GVA growth and employment growth within the intensive ICT sectors has experienced a considerable increase in Andalucía. *Fourth*, growth rates and levels of labour productivity are remarkably higher in the intensive ICT sectors. *Fifth*, the study shows that ICT assets do have an important contribution in both GVA growth and productivity growth in a few intensive ICT service sectors. *Finally*, our main conclusion is that while the contribution of ICT to GVA and productivity growth in Andalucía are noticeable, the advantages related to ICT diffusion have not yet reached their full potential.

Framework of analysis

This section briefly describes the standard growth accounting breakdown. All asset types, both ICT and non-ICT, are seen in terms of inputs. The production of good Q_{st} in sector s at time t is given by the following homogeneous of degree one technology:

$$Q_{st} = TFP_{st} \left(HL_{st} \cdot KH_{st}\right)^{\alpha_{ls}} \left(\prod_{i=1}^{6} K(i)_{st}^{\alpha_{is}}\right), \qquad (1)$$

where i = (1) constructions and other buildings, (2) machinery and other equipments, (3) transport equipments, (4) communication equipment, (5) hardware and (6) software, and α_{ls} and α_{is} are, respectively, the share of labour and capital assets over total output. Assets $K(i)$ labelled as i = 1, 2, 3 will be referred as non-ICT capital, and assets labelled as i = 4, 5, 6 will be referred as ICT capital inputs. Appendix B discusses how this "primal approach" is converted into the "dual approach", which allows the use of an exogenous rate of return within a non-parametric environment to calculate the estimates of contributions to growth and productivity.

TFP_{st} is the total factor productivity. Notice that a change in TFP_{st} increases or contracts the amount of good Q_{st} produced without altering the combination of inputs employed by the typical firm of sector s at time t. Hence, these changes in TFP_{st} are usually associated to efficiency in the use of productive factors. HL_{st} is total hours worked in sector s at time t, and KH_{st} is a labour qualification index that increases when sector s accumulates skilled in relation to unskilled labour force. Appendix A gives a detailed explanation on how index KH_{st} has been obtained. Simple algebra goes to the standard growth accounting equation:

$$\gamma_s^Q = \Delta TFP_{st} + \alpha_{ls}\left(\gamma_{st}^{HL} + \gamma_s^{KH}\right) + \sum_{i=1}^{6} \alpha_{is}\gamma_s^{K(i)}, \qquad (2)$$

where γ^{χ}_{st} is the growth rate of χ in sector s, with $\chi = Q, HL, KH, K(i)$.Therefore, as long as we assume constant return to scale (homogeneity of degree one), output growth can be written as a linear combination of inputs growth rates. Consequently, TFP is estimated as a residual. Expression (2) can be also expressed as the growth rate of labour productivity:

$$\gamma_s^Q - \gamma_s^{HL} = \Delta TFP_s + \alpha_{1s}\gamma_s^{KH} + \sum_{i=1}^{6} \alpha_{is}(\gamma_s^{K(i)} - \gamma_s^{HL}) \qquad (3)$$

In sector *s*, output per unit of labour ($\gamma^Q_{st} - \gamma^{HL}_{st}$) grows because ratios of capital per worker increase and/or the human capital index improves. Moreover, gains (or losses) in efficiency, as measured by ΔTFP_s, entails an expansion (or contraction) on labour productivity. This simple methodology will be further applied here in order to gain a deeper insight into the sources of output growth in an international context and in Andalucía.

A look at international evidence

Table 1.a reports calculations of labour productivity growth in hours worked ($\Delta(Y/L)$), total factor productivity growth (ΔTFP), and the ratio of ICT capital over the sum of all asset types of capital (*ICT/K*), for the EU-15 countries and the US, over four sub-periods from 1980 to 2004 (as measured by Timmer, Ypma and van Ark (2003) using data from the EU KLEMS database).[4] Countries in this table are ordered according to the ICT capital deepening (*ICT/K*) during the last period 2000-2004. Some enlightening statistics are calculated in the lowest rows of the table. The ratio of capital deepening *ICT/K* had a continuous growth from 1980 to 2004, indicating that the proportion of this capital stock accumulated by these economies is on average four times greater in 2004 what it was in 1980 (as measured by the average and the median). According to this criterion, five countries can be considered as intensive ICT users: Belgium, Finland, United Kingdom, Sweden and the United States. The ratio corresponding to the US economy in 2000-2004 is well above the mean and the median of the sample of countries considered here. France and Spain appear as ICT non-intensive users (see also Daveri, 2000; and Colecchia and Schreyer, 2002). Interestingly, the heterogeneity in the ICT use has increased across the total period, as shown by the standard deviation, from 0.0055 to 0.0136.

Table 1.a also displays a labour productivity slowdown during the last period, 2000-2004, for the ICT non-intensive users. However, for the intensive ones, there is an upward trend in productivity beginning in 1990. There is a similar pattern for the dynamics of efficiency, as captured by the TFP growth.

The lowest panel of this table presents the correlation coefficients between ICT deepening and productivity, between ICT deepening and TFP, and, finally, between productivity and TFP, for the four sub-periods under consideration. Correlation of ICT deepening with the two other variables is rather low and negative. However, for the period 2000-2004 this correlation becomes positive. Relative to its EU partners, Spain exhibits a poor performance in productivity growth and a negative TFP growth during 2000-2004.

4 See http://www.euklems.net/.

Finally, Table 1.b computes a simple breakdown of GDP growth and productivity growth for the period 2000-2004, using the same database. Output is assumed to be produced by three inputs, labour (in hours worked), ICT capital and non-ICT capital. The first panel of the table collects the growth rates of both GDP and the three inputs. ICT growth rates contrast sharply with those of non-ICT capital. Employment grows negatively in most of the countries. The second panel of Table 1.b presents the cost shares. Labour cost share is about 2/3 of total costs, as is usual in this type of analysis. The use of ICT input represents about 3% of total costs. Using these shares for weighting the growth rates, the last two panels of Table 1.b provide a breakdown of GDP growth and productivity growth. TFP growth is calculated as a residual, therefore rendered as a part of the growth factor unexplained by the use of production inputs.

ICT capital appears as the main contributor to GDP growth within the ICT intensive group. Outside this group, ICT is also the most relevant factor for German GDP growth. Ireland and Greece are two important cases, where GDP growth has been mainly based on non-ICT capital inputs, and TFP growth rates are even higher than those of the ICT intensive group. The contribution of ICT to labour productivity growth always stands out as more important than that of non-ICT in the ICT intensive group. In the rest of countries, productivity growth is mainly due to the non-ICT input. Hence, ICT account for an important fraction of output growth and productivity growth for the intensive users. In the EU-15 as a whole, non-ICT capital favour output growth and productivity growth more than ICT input. Therefore, comparing all these contributions with those of the US (see the first and last rows of Table 1.b), the European growth pattern appears to be rather different from that of the US economy. Now considering the specific case of Spain, this country appears to be a low-intensive ICT user. ICT is the smallest source of GDP growth, while employment is the main one. The effect of non-ICT on productivity is higher than that of ICT (0.41% > 0.19%), but the negative sign in TFP growth almost absorbs these increases (i.e. 0.41+0.19−0.53 = 0.07), implying that productivity grows at a rate equal to 0.07%.

Table 1.a: ICT-Capital deepening, productivity and TFP growth: An international comparison

	1980-1990			1990-1995			1995-2000			2000-2004		
	Δ(Y/L)	ΔTFP	ICT/K	Δ(Y/L)	ΔTFP	ICT/K	Δ(Y/L)	ΔTFP	ICT/K	Δ(Y/L)	ΔTFP	ICT/K
EU-15	2,3%	1,15%	1,55%	2,4%	1,18%	2,32%	1,8%	0,86%	3,30%	1,1%	0,36%	4,99%
France	2,9%	1,37%	1,06%	1,3%	0,01%	1,61%	2,5%	1,45%	2,32%	1,5%	0,45%	3,47%
Spain	3,0%	1,95%	1,26%	2,3%	0,94%	2,02%	-0,1%	-0,35%	2,57%	0,1%	-0,54%	3,60%
Netherlands	2,0%	1,07%	0,83%	1,3%	0,64%	1,41%	0,8%	0,59%	2,25%	0,7%	0,16%	3,90%
Ireland	3,7%	2,71%	0,68%	3,6%	2,99%	0,87%	6,0%	4,45%	1,85%	4,2%	1,98%	4,17%
Greece	-0,1%	-0,50%	1,22%	0,4%	0,01%	1,73%	2,9%	1,91%	2,59%	2,9%	1,80%	4,27%
Austria	1,6%	0,49%	1,94%	1,8%	0,65%	2,60%	3,0%	1,72%	3,31%	1,4%	0,18%	4,74%
Luxemburg	3,6%	2,13%	2,04%	2,3%	0,98%	3,04%	2,7%	1,63%	3,40%	-0,2%	-0,95%	4,76%
Germany	2,6%	1,54%	1,92%	3,1%	1,84%	2,70%	2,2%	1,28%	3,37%	1,2%	0,61%	4,76%
Portugal	1,7%	1,57%	1,67%	3,6%	1,58%	2,32%	2,5%	1,01%	3,31%	0,5%	-0,35%	5,32%
Denmark	2,2%	0,95%	1,26%	2,6%	1,44%	2,27%	2,4%	0,82%	3,58%	1,4%	-0,08%	5,41%
Italy	1,9%	0,86%	1,81%	2,2%	1,00%	2,95%	1,3%	0,24%	4,12%	-0,4%	-1,19%	5,92%
Belgium	2,0%	0,79%	1,01%	2,3%	1,24%	1,97%	2,9%	1,70%	3,36%	0,6%	0,27%	6,16%
Finland	2,7%	1,47%	1,01%	2,0%	0,87%	1,92%	3,4%	3,32%	3,56%	2,8%	2,01%	6,68%
United Kingdom	2,3%	1,17%	1,35%	2,9%	1,60%	2,50%	2,2%	1,06%	4,37%	2,0%	1,51%	7,03%
Sweden	1,4%	0,40%	1,86%	2,0%	0,95%	2,74%	2,6%	1,34%	4,42%	2,6%	1,92%	7,17%
United States	1,5%	0,61%	2,78%	1,2%	0,55%	4,27%	2,3%	1,14%	6,33%	2,8%	1,72%	9,67%
Averages	2,18%	1,16%	1,48%	2,17%	1,08%	2,31%	2,47%	1,46%	3,42%	1,51%	0,59%	5,44%
Median	2,11%	1,12%	1,30%	2,23%	0,96%	2,30%	2,47%	1,31%	3,36%	1,36%	0,36%	5,04%
Standard deviation	0,0093	0,0077	0,0055	0,0087	0,0073	0,0079	0,0130	0,0113	0,0108	0,0130	0,0109	0,0163
Correlation Coefficients												
Product-ICT	-0,2395			-0,1110			-0,1507			0,2672		
TFP-ICT	-0,2471			-0,2162			-0,2540			0,3933		
Product-TFP	0,9351			0,8979			0,9356			0,9435		

Source: Timmer, Ypma and van Ark (2003) and own calculations

Table 1.b.: An international outlook of factors contribution to growth and productivity, 2000-2004.

	Growth Rates					Shares			Contribution to growth				Contribution to productivity	
	Y	L	ICT	Non-ICT	Y/L	L	ICT	Non-ICT	L	ICT	Non-ICT	TFP	ICT	Non-ICT
EU-15	1,46%	0,40%	8,83%	1,70%	1,05%	0,6575	0,0347	0,3077	0,26% <	0,31% <	0,52%	0,36%	0,29% <	0,40%
France	1,35%	-0,20%	8,60%	2,45%	1,54%	0,6441	0,0250	0,3310	-0,13% <	0,21% <	0,81%	0,45%	0,22% <	0,87%
Spain	2,53%	2,46%	9,40%	3,77%	0,07%	0,6623	0,0278	0,3099	1,63% >	0,26% <	1,17%	-0,53%	0,19% <	0,41%
Netherlands	0,63%	-0,09%	8,99%	1,14%	0,72%	0,7158	0,0270	0,2572	-0,06% <	0,24% <	0,29%	0,16%	0,24% <	0,32%
Ireland	5,04%	0,86%	13,47%	5,03%	4,19%	0,5359	0,0255	0,4386	0,46% >	0,34% <	2,21%	2,03%	0,32% <	1,83%
Greece	4,21%	1,26%	15,09%	5,30%	2,95%	0,7803	0,0241	0,1956	0,99% >	0,36% <	1,04%	1,83%	0,33% <	0,79%
Austria	1,14%	-0,22%	10,90%	2,14%	1,36%	0,6318	0,0333	0,3350	-0,14% <	0,36% <	0,72%	0,20%	0,37% <	0,79%
Luxembourg	2,71%	2,90%	12,86%	4,26%	-0,19%	0,6232	0,0313	0,3455	1,81% >	0,40% <	1,47%	-0,97%	0,31% <	0,47%
Germany	0,51%	-0,69%	7,75%	0,32%	1,19%	0,6648	0,0326	0,3026	-0,46% <	0,25% >	0,10%	0,61%	0,28% <	0,30%
Portugal	0,48%	-0,04%	10,16%	2,30%	0,52%	0,7158	0,0283	0,2558	-0,03% <	0,29% <	0,59%	-0,36%	0,29% <	0,60%
Denmark	1,29%	-0,08%	11,16%	2,98%	1,36%	0,6490	0,0456	0,3054	-0,05% <	0,51% <	0,91%	-0,08%	0,51% <	0,94%
Italy	0,88%	1,32%	10,05%	2,46%	-0,45%	0,6047	0,0375	0,3578	0,80% >	0,38% <	0,88%	-1,18%	0,33% <	0,41%
Belgium	1,34%	0,74%	10,97%	0,36%	0,60%	0,7026	0,0400	0,2574	0,52% >	0,44% >	0,09%	0,29%	0,41% >	-0,10%
Finland	2,27%	-0,54%	10,84%	0,24%	2,80%	0,6409	0,0493	0,3098	-0,34% <	0,53% >	0,07%	2,00%	0,56% >	0,24%
United Kingdom	2,32%	0,30%	8,27%	1,09%	2,02%	0,6949	0,0440	0,2611	0,21% <	0,36% >	0,28%	1,47%	0,35% >	0,21%
Sweden	2,05%	-0,60%	6,83%	0,69%	2,65%	0,6927	0,0533	0,2540	-0,41% <	0,36% >	0,18%	1,92%	0,40% >	0,33%
United States	2,38%	-0,40%	9,14%	1,76%	2,78%	0,7005	0,0578	0,2417	-0,28% <	0,53% >	0,43%	1,71%	0,55% >	0,52%

Source: Timmer, Ypma and van Ark (2003) and own calculations

Data and methodology

Bearing in mind the results of the contribution of ICT to productivity growth in Spain, it is now worth considering the special case of Andalucía. First, it is important to note that ICT use in Andalucía is below that of Spain, as documented by the official survey ETICCE (IEA 2002-2004), although it is worth mentioning that there are some signs of convergence towards the Spanish national levels.[5] On the basis of the framework developed in Section 2, a growth accounting exercise requires the use of growth rates corresponding to output and production factors. This study follows the main branch of recent literature of growth accounting and the recommendations of OECD (2001a and b; Mas and Quesada, 2005), which use the concept of capital services, instead of gross or net capital stocks.

The aim is to capture the productive services embedded in the stock of capital. The procedure to obtain series of capital services, to be used in growth accounting exercises, can be summarized in three stages.[6] First, we need to have the capital stock expressed in standard efficiency units (we shall refer to this type of capital stock as productive capital); the OECD (2001b) describes this process, which consists of converting the gross stock of the assets to constant prices and then applying age-efficiency coefficients to the different vintages. Second, we have to aggregate these separate stocks to obtain overall measures of capital services for different kinds of activities or for the economy as a whole; this is done using the user costs of capital as weights. The user costs of capital can be seen as the prices of capital services and are assumed to measure the relative marginal productivity of different kinds of assets. Third, growth rates of capital services series have been computed using Törnqvist indexes. It allows us to explicitly consider changes in the structure of capital stock as a result of changes in the relative prices of assets.[7]

As regards data, the main limitation is that there are no available series for capital assets disaggregated as ICT and non-ICT for Andalucía. We have overcome this problem by combining the works by Mas, Pérez-García and Uriel (2003) and Mas and Quesada (2005a and b).

5 ETTICE stands for Encuesta de uso de las Tecnologías de la Información y de la Comunicación y del Comercio Electrónico en las empresas. It surveys the use of ICT by firms and is elaborated by Instituto Nacional the Estadística (INE) according to the methodology proposed by Eurostat.

6 Appendix B contains further details on how series of capital services in Andalucía have been elaborated.

7 These variations in the relative prices of assets are relevant in the case of ICT capital assets, especially in the case of hardware equipments where a huge reduction is observed across 1995-2004.

Given these data sets, we have used the following criterion to identify the series for private capital at regional level. First, we use the work of Mas and Quesada (2005a), which provides an estimation of eighteen productive capital assets for Spain for 1964-2002. These series are also disaggregated into 25 market economy sectors. Non-ICT series have been grouped into three assets: building and construction, machinery and other equipment, and transport equipment. As standard in this type of analysis, ICT series have been aggregated into three assets: communication equipment, hardware and software. We have then followed a Box-Jenkins ARIMA procedure to identify their structure and projected their values over the period 2003-2004.

Second, we have borrowed from Mas, Pérez-García and Uriel (2003) their estimation of series for private and public capital for the period 1964-1998. Private capital is also disaggregated by 25 market economy sectors (agriculture and fishing sectors included) at regional level. For each sector in Andalucía and Spain, hence for 25 * 2 = 50 series, we have identified its ARIMA structure and projected its value over the period 1999-2004. Thus, 25 ratios of regional capital stock relative to the national capital stock have been calculated. These ratios are reasonably stable across the total period 1964-1998 and especially in 1990-1998 in all sectors and they do not suffer from discontinuities from 1999-2004. Within each sector, it has been assumed that these time varying ratios can been used to identify the series of capital at the regional level, that is, series of capital for the national aggregate have been pre-multiplied by these ratios.

Series for Gross Value Added (GVA) for these 25 sectors come from the Regional Accounting of Instituto Nacional de Estadística (INE) for the period 1995-2004. The required level of sectoral disaggregation for the last two years is not available in some cases. Therefore, the latest available observation of the incomplete series has been extrapolated by means of the aggregate growth rates of the set of sectors that includes the sectoral breakdown we need. Since residential capital does not belong to the concept of productive capital, those which refer to rents from dwellings, incomes from private households with employed persons and real estate businesses have not been considered in the values of GVA (and, consequently, neither have they been considered in analogous measures of remuneration of employees or human capital).

Employment and education

Table 2 shows the distribution of employment by educational levels in Spain and Andalucía for the period 1987-2004. Education is classified in five levels: illiteracy, primary education, secondary education, professional training and tertiary (university) education. The percentage of illiteracy in Andalucía is double the national average for the entire period. In 2004, illiteracy rate among the active population in Andalucía was 6% compared to 3% in Spain. The comparison of these rates over time shows that Andalucía lags about one decade behind Spain in the reduction of illiteracy. Regarding the three upper levels of education, the regional evolution follows that of Spain, although the share of qualified labour force in Andalusia is 2 percentage points lower than the national average. This gap remains the same throughout the considered period.

Table 2: Labor force qualification

Employment structure by educational levels.

Spain	1987	1990	1995	2000	2004
Illiterate	11,16%	10,78%	6,94%	5,15%	3,09%
Primary education	46,16%	38,49%	30,35%	20,58%	16,29%
Secundary education	26,19%	30,37%	34,90%	39,32%	42,17%
Professional Training	5,46%	8,10%	12,27%	15,81%	16,58%
Tertiary education	11,03%	12,26%	15,54%	19,14%	21,87%
Total	100,00%	100,00%	100,00%	100,00%	100,00%
Andalucía	**1987**	**1990**	**1995**	**2000**	**2004**
Illiterate	21,45%	16,87%	12,73%	10,01%	6,22%
Primary education	41,03%	38,02%	29,54%	21,62%	21,60%
Secundary education	23,30%	28,20%	32,78%	36,44%	38,17%
Professional Training	3,81%	6,30%	10,46%	14,04%	14,52%
Tertiary education	10,41%	10,61%	14,50%	17,89%	19,49%
Total	100,00%	100,00%	100,00%	100,00%	100,00%

Source: INE, IEA and own calculations

We have developed an index of human capital accumulation that explicitly takes into account these different levels of education. Appendix A gives a detailed technical explanation on how this index has been constructed. We use the estimation of structural wages surveyed in 2002 (our central year) by INE, as a proxy for productivity. Unfortunately, insight into the 25 aforementioned sectors has not been possible due to sampling errors. Data are only available for 10 groups of sectors, as specified in Table 3. The main problem of this classification lies in the fact that it deals with heterogeneous sectors, according to ICT deepening, and this may induce a fixed effect bias. Table 3 specifies how market sectors have been mapped into these ten groups. The criterion for classifying the different sectors according to their ICT intensity, that is, the ratio of ICT capital over the total stock of capital, is borrowed from Mas and Quesada (2005b and 2006). As we can observe from Table 3, eight sectors are identified as intensive users, three of them belonging to energy and industry, and the remaining ones to market services.

In Table 3, some ICT intensive sectors, like "Energy and water", "Pulp, paper, printing & publishing" and "Electric, electronic & optic equipment", appear grouped together along with non-ICT intensive sectors. As the ICT intensity may imply a higher demand for qualified workers and a substitution of unskilled ones, this measure of human capital accumulation can be seriously distorted in these sectors. It is noticeable, however, that intensive ICT users within the service sector are grouped with a higher homogeneity. Another possible source of bias can arise from over-qualification of the labour force: skilled workers may be employed in occupations which actually require lesser levels of qualification.

Notwithstanding these problems, the three remaining columns of Table 3 present the estimated index for 2000 and 2004 (where the base year is 1995 and the index has been normalized by 100). The highest increases are probably concentrated into the service sectors (groups 6, 7, 8 and 10). This may indicate that the effect of the fixed effect bias is moderate in these sectors. Not surprisingly, "Transport & communications", "Financial intermediation" and "Business services" present the highest increases in labour force qualification.

Table 3: Labor Force Cualification Index

Group	Sectors		1995	2000	2004
1	Agriculture & cattle farming	Non-ICT intensive	100,00	103,34	105,27
	Fishing	Non-ICT intensive			
2	Pulp, paper, printing & publishing	ICT-Intensive	100,00	104,35	108,21
	Textiles, clothing, leather and footwear	Non-ICT intensive			
	Wood & products of wood & cork	Non-ICT intensive			
	Food, drink and tobacco	Non-ICT intensive			
3	Energy and water	ICT-Intensive	100,00	101,16	104,00
	Mineral oil refining, coke & nuclear fuel	Non-ICT intensive			
	Chemicals	Non-ICT intensive			
	Rubber & plastics	Non-ICT intensive			
	Fabricated metal products	Non-ICT intensive			
	Mining and quarrying	Non-ICT intensive			
	Other non-metallic mineral products	Non-ICT intensive			
4	Electric, electronic & optic equipment	ICT-Intensive	100,00	102,27	103,64
	Machinery & mechanical equipment	Non-ICT intensive			
	Transport equipment manufacturing	Non-ICT intensive			
	Miscellaneous manufacturing	Non-ICT intensive			
5	Construction	Non-ICT intensive	100,00	102,91	104,02
6	Wholesale & retail trade; Repairs	Non-ICT intensive	100,00	104,64	107,00
	Hotels and catering	Non-ICT intensive			
7	Transport and communications	ICT-Intensive	100,00	106,32	111,52
8	Financial intermediation	ICT-Intensive	100,00	108,30	108,85
	Business services	ICT-Intensive			
9	Private health & social services	ICT-Intensive	100,00	101,99	103,50
	Private education	Non-ICT intensive			
10	Other community, social & personal services	ICT-Intensive	100,00	106,14	108,84
	Total market economy		100,00	104,08	106,12

Source: INE, IEA and own calculations

Growth accounting exercise

1.1. A look at some Andalusian growth facts

Andalucía is one of the poorest regions of Spain in terms of income per capita. As regional statistics series show since they have been available for Spain, Andalusian GDP per capita has never exceeded 80% of the Spanish average value. There are, however, several phases in the relative evolution of Andalusian income per capita compared to that of Spain as a whole

Table 4 shows the values of this variable during the period 1980 and 2005.

Table 4. Relative GDP per capita AND-Spain, 1980-2005 (euros of 2000)

	Spain	Andalucía	% GDP per capita AND/Spain
1980	2.623	1.944	74,13
1981	2.623	1.944	74,13
1982	2.927	2.168	74,06
1983	3.367	2.543	75,53
1984	3.825	2.896	75,71
1985	4.310	3.227	74,87
1986	4.743	3.642	76,80
1987	5.415	4.117	76,03
1988	6.034	4.644	76,96
1989	6.687	5.097	76,22
1990	7.483	5.611	74,98
1991	8.313	6.387	76,83
1992	9.090	6.970	76,68
1993	9.769	7.373	75,48
1994	10.041	7.476	74,45
1995	10.638	7.926	74,51
1996	11.420	8.394	73,50
1997	12.081	8.877	73,48
1998	12.830	9.427	73,48
1999	13.676	9.941	72,69
2000	14.519	10.531	72,54
2001	15.562	11.433	73,46
2002	16.534	12.228	73,95
2003	17.425	13.071	75,02
2004	18.273	13.942	76,30
2005	19.383	14.960	77,18

Source: INE (several years)

It is worth noting that the relative position of Andalucía over the entire period is highly stable, although a certain degree of convergence in income per capita can be identified from 2000. From late 70s onward, Spain experienced a sudden halt regarding regional convergence (see, for instance, López-Bazo et al. (1999)).

This evidence has encouraged further research into the nature and characteristics of Andalusian growth patterns. Rodríguez, Martínez and Romero (2005) provide some insights into the regional dynamics of Spain over the period 1980-2002. Particularly, they reject the hypothesis of unconditional convergence among Spanish regions. On the contrary, it has been suggested that Spanish regions converge to differentiated steady states, rather than there being a common steady state level. In this sense, the evidence found, regarding the persistence of inequalities across the Spanish regions, that income differentials have hardly narrowed. Thus, initial conditions prove to be significant in the analysis of the relative position of regions in terms of income per capita.

The results by Rodríguez *et al* (2005) are consistent with the evidence of a maximum level for the relative income per capita of Andalucía. Table 4 showed that Andalusian income per capita has never increased above the 80% ceiling of Spanish income per capita. This can be an indication that structural factors such as investment and saving rates, human capital stock, sectoral structure, level of technology and others, may explain to a large extent the unsatisfying convergence of the Andalusian region. Accordingly, issues such as ICT capital accumulation and the role of new technologies in the production process call for further research, as they are increasingly becoming part of the structural conditions for growth.

Table 5 presents some descriptive statistics for Andalucía and compares them with those of Spain: GVA growth rate, total employment in labour growth rate (in hours worked), and the resulting productivity growth. The regional business cycle follows the national trend. The expansion is higher in the first period 1995-2000, and slowed down during 2000-2004. Andalusian GVA growth rate is always higher than the Spanish one. Employment creation is also higher during the first sub-period and superior to the GVA growth rate. As a result, labour productivity growth is negative during 1995-2000 and positive during 2000-2004. On average, labour productivity is positive but nearly zero throughout the decade. Therefore, the upsurge in productivity takes place in 2000-2004, as it does in Spain, due to a moderate employment creation relative to output growth. A detailed description of the properties of the

Andalusian business cycle can be found in Pérez, Rodríguez and Usabiaga (2003) and Leal, Pérez and Rodríguez (2004).

Table 5: Real Gross Value Added, employment and labor productivity

	Andalucía			Spain		
	95-00	00-04	95-04	95-00	00-04	95-04
Real GVA	4,16%	2,75%	3,53%	3,57%	2,25%	2,98%
Hours worked	4,82%	1,59%	3,39%	3,51%	1,58%	2,66%
Productivity growth	-0,66%	1,16%	0,14%	0,06%	0,67%	0,32%

Source: INE, IEA and own calculations

1.2. Aggregate impact

As was shown in Section 2, the growth accounting exercises basically consist of relating growth rates of output to those of production factors. A primary approximation is to observe the behaviour of the relevant growth rates over the period under consideration. Table 6 presents growth rates for productive capital (considering six types of assets), hours worked and human capital in Andalucía over 1995-2004, split into two time intervals.

		95-00	00-04	95-04
	Real GVA growth	4,16%	2,75%	3,53%
Growth rates	Constructions	5,30%	6,40%	5,79%
	Transport equipments	4,56%	4,94%	4,72%
	Machinery	4,41%	4,63%	4,51%
	Communications	8,40%	7,54%	8,02%
	Hardware	23,48%	18,59%	21,31%
	Software	11,98%	12,45%	12,19%
	KH	0,80%	0,48%	0,66%
	Hours (HL)	4,82%	1,59%	3,39%
Cost shares	Constructions	0,0728	0,0615	0,0689
	Transport equipments	0,0416	0,0473	0,0442
	Machinery	0,0875	0,0835	0,0856
	Communications	0,0251	0,0270	0,0259
	Hardware	0,0117	0,0101	0,0110
	Software	0,0127	0,0207	0,0164
	All asset types	0,2515	0,2501	0,2520
	Labor	0,7485	0,7499	0,7480
Contribution to growth	Non-ICT KP	0,96%	1,01%	0,99%
	ICT KP	0,64%	0,65%	0,64%
	Communications	0,21%	0,20%	0,21%
	Hardware	0,28%	0,19%	0,23%
	Software	0,15%	0,26%	0,20%
	Hours (HL)	3,61%	1,19%	2,54%
Contribution to Productivity	Labor productivity growth	-0,66%	1,16%	0,14%
	Non-ICT KP	-0,01%	0,71%	0,32%
	Constructions	0,04%	0,30%	0,17%
	Transport equipments	-0,01%	0,16%	0,06%
	Machinery	-0,04%	0,25%	0,10%
	ICT KP	0,40%	0,56%	0,46%
	Communications	0,09%	0,16%	0,12%
	Hardware	0,22%	0,17%	0,20%
	Software	0,09%	0,22%	0,14%
	KH	0,60%	0,36%	0,49%
	TFP	-1,64%	-0,47%	-1,13%
	TFP-Spain	-2,05%	-1,41%	-1,71%

Table 6: Growth accounting exercise for total market economy

The magnitude of growth rates of non-ICT assets was in line with those that correspond to regional output. While regional market GVA grew at an average annual rate of 3.53%, the non-ICT capital inputs increased their stocks at growth rates within a range from 4.51 of machinery to 5.79 of construction per year. The dynamics of non-ICT capital was the opposite to that of output. Indeed, real GVA showed a deceleration when both sub-periods are compared, while the three types of capital assets had higher growth rates in the second part of the studied period.

Hours worked, however, showed parallel behavior to output. With an annual growth rate of employment of 4.82% over 1995-2000, the increase during 2000-2004 was of only 1.59 per year. This is again an indication of the high dependence of Andalusian economic growth on the behavior of employment, with a significant correlation between output and hours worked growth.

Things were different in the case of ICT assets. The growth rates of the three ICT inputs capital were notably higher than those corresponding to output and non-ICT capital, especially in the cases of hardware and software. The dynamics of non-ICT assets was not homogeneous. While Communications and Software held their growth rates (the first with a slightly decreasing trend, the second with the opposite behavior), hardware showed a declining evolution: growth rate was of 23.48% in 1995-2000 and of 18.59% in 2000-2004.

In growth accounting exercises, these dynamics of production factors have to be weighted on the basis of the cost shares they represent. The expressions we refer to are those of Appendix B, in particular the α's calculated from (B3) and (B4), in which the share of cost of each production factor over total cost is measured. As we have already mentioned, this approach can be seen as the dual approximation to the participation of factors over output. Table 6 also includes the values for these cost shares.

Labour input was the most important production factor in terms of total cost, accounting for three quarters of total costs.[8] Considering the case of traditional non-ICT capital inputs, we find that the ranking was headed by machinery (with 0.085), followed by construction (0.068) and transport equipment (0.042). Their values over time were stable, although a slightly decrease is detected in construction. ICT capital assets had small cost shares over 1995-2004. Their alphas were within the range between 0.016 and 0.026.

One of the reasons behind this fact is related to the small growth rates (even negative in some cases and periods) experienced by prices of ICT assets. This point could be strong enough to compensate for the intense growth rates of ICT productive capital stocks (.rst panel of Table 6) and to stabilize their cost shares. Hardware even decreases this value when period 1995-

8 In fact, its values are slightly higher than those corresponding to the traditional figures given by National Accounts (2/3). This is due to the methodology we have used to compute the capital services and the reassigning of mixed incomes.

2000 is compared to 2000-2004. Software assets showed the opposite pattern: their cost share increased from 0.012 to 0.020.

Expressions (2) and (3) of Section 2 are now exploited to calculate the decomposition of growth rates for sectoral output and productivity. These results are also collected in Table 6. A number of facts are worthy of noting. First, the labour contribution appears as the most relevant engine of aggregate economic growth in Andalucía in both sub-periods. Hours worked accounted for over 72% of the real GVA growth rate during the period 1995-2004. This pattern does not hold by sub-periods, however. Labour contributed 3.61 percentage points to the GVA growth rate of 4.16% over 1995-2000 (86% of total GVA growth). However, between 2000 – 2004, it only contributed 1.19% when the output grew by 2.75% a year, (43% of total GVA growth).

Second, it is easy to see that non-ICT capital inputs had a bigger impact on growth than ICT capital, which amounted to two thirds of non-ICT assets contribution. It must be noted that this effect of ICT inputs affected economic growth in Andalucia more than it did in Spain (Mas and Quesada, 2006). While the contribution of Andalusian ICT assets was of 18% of GVA total growth (0.64% over 3.53% of GVA growth), this figure was only of 12% for the national level. Another difference arises from the fact that both types of capital showed remarkably steady contributions to GVA growth over the entire period, which is not the case for the Spanish sample.

Third, we can confirm the particular behaviour (and impact) followed by the different kinds of ICT assets detected when only the growth rates of these variables were studied. Indeed, while the contribution to growth of communications assets kept a stable pattern over time, hardware inputs presented a significant decrease in its contribution and the effect of software capital experienced a rising trend. This can be interpreted as an indication of the fact that ICT introduction and use in Andalucía are at different stages. Particularly, it is reasonable to think that investment in hardware precedes that of software, and therefore different dynamics drive their evolution. Additionally, this point can also be linked to the particular laws of returns to scale of each type of ICT asset.

Fourth, the impact of human capital accumulation in Andalucía was positive although it has decreased from the period 1995-2000 to the period 2000-2004. This is not the case for Spain as a whole. At least two partial explanations can be found behind this result. The first is related to the huge empirical literature regarding the ambiguous effect of human capital on growth (De la Fuente (2002)). De la Fuente and Domenech (2006) have pointed out that the insignificant (or even negative) effect of education and qualification on growth is due to measurement errors in the variables used to proxy human capital, which lead to a downward bias. When data at regional level are involved, the probability of suffering this bias is higher. The second reason for the decreasing contribution of labour force qualification might be a certain exhaustion of the model of human capital accumulation, strongly based during the late 80s and 90s on university tuition, which does not necessarily mean an efficient match between job vacancies and labour supply. This hypothetical explanation would be more intense at regional level as long as the regional job matching is not as efficient as in the deeper national labour market, and the over-qualification problem appears with more intensity at regional level.

Fifth, the value of TFP was negative for the entire period and for the subdivisions into two time spans. This last fact is similar to the result obtained by Estrada (2006) and Mas and Quesada (2006) for Spain. This negative behaviour of TFP is one of the weak points of Spanish and Andalusian economy, although both results should be taken with caution. At this point, we should be aware that this negative TFP could be the result of measurement errors of employment and output growth rates. Some technical considerations may guess that employment growth could be overestimated while output growth underestimated.

Sixth, regarding the decomposition of labour productivity growth, the most significant finding is that ICT assets contributed more to productivity growth than non-ICT assets. The impact of traditional capital inputs was about 30% smaller than that of new technologies. This situation was similar to that of Spain (Mas and Quesada, 2006), although in the Andalusian case the relative impact of ICT was not as relevant as it is in Spain. However, in contrast to the national sample, the influence of ICT on productivity growth has increased when the period 1995-2000 is compared to 2000-2004. Again, hardware equipment showed a decreasing contribution to productivity growth as time went by, and the strong contribution made by software continued to grow. As regards communications assets, their impact was of around 0.12 percentage points, also with an increasing trend.

In conclusion, the order of dominance for the GVA growth rate can be written as:

L > non-CT > ICT

while the order of dominance for the labour productivity decomposition could be written as:

ICT > non-ICT.

1.3. Sectoral impact

Next, we follow the typology proposed by Mas and Quesada (2006) to classify sectors as intensive or non-intensive users. Table 7 presents the shares and contributions of each sector to total market GVA and employment. The GVA generated in the intensive ICT sectors was about 38% across the decade. Within this sector, five service sectors accounted for 34% of total GVA: "Transport and communications", "Financial intermediation", "Business services", "Private health and social services", and "Other community, social and personal services". Within the non-intensive ICT sectors, the primary sector plus four industrial sectors accumulated half of market GVA generation, which widely exceeds the shares in the intensive ICT sector: primary sector, "Food, drink and tobacco", "Construction", "Hotels and catering", and "Wholesale and retail trade and repairs". In this last sector, the share on GVA was the highest one. The stability of these shares throughout time was very high, with only minor differences.[9] Consequently, the way and pattern through which GVA has been generated has not changed between 1995 and 2004. Regional GVA generation is concentrated in a few sectors of the economy.

Over the entire period, the share of hours worked in the intensive ICT sectors was smaller than it was in the non-intensive ICT sectors. Additionally, the share of ICT intensive sectors in employment was below its share in GVA, rendering its average labour productivity higher. This fact was especially clear in the case of Business services: it accounted for 14% of regional GVA but its share on hours worked was only about 6%. The only exception to this stylized fact among the ICT intensive sectors was "Other community, social and personal services", in which the share on regional employment was slightly higher than its share in GVA over the decade.

[9] The sector Transport and Communications increased its share on GVA by 1 percentage point between 1995 and 2004, while remained stable in Spain. Construction increased its share by almost 4 pp in the national sample while below 2 pp in Andalucía.

Regarding the right-side panel of Table 7, we calibrate the contribution of different sectors to total GVA growth and total employment growth. Intensive ICT sectors have contributed with 1.52% and 1.25% of total GVA growth for periods 1995-2000 and 2000-2004, respectively. Total GVA growth rate has been 4.16% during 1995-2000 and 2.75% for 2000-2004. As a consequence, the contribution of intensive ICT sector has become much more relevant in this second sub-period: for each one percentage point in market GVA growth, the ICT intensive sectors contributed by 0.36 (= 1.52/4.16) during the first period, and by 0.45 (= 1.25/2.75) during 2000-2004. Using a similar arithmetic, for each 1% of employment creation, the contribution of intensive ICT sectors has increased from 0.20 to 0.25.

It should also be highlighted from Table 7 that a quarter of total hours worked in Andalucía has taken place in sector "Wholesale & retail; Repairs", this is even more than total hours worked in the intensive ICT group, 23%. The "Construction" sector accumulated a 16:38% in total hours worked, this represented a 5% increase from 1995 to 2004. As regards the contribution to hours-worked growth, most of the employment creation has concentrated in these two sectors during the whole period, 1995-2004. "Hotels and catering" and the primary sector also showed high rates in the share of hours worked, 9% and 13%, respectively.

Table 7: Share and contribution of each industry to GVA and employment

	Shares				Contributions					
	Market Real GVA		Hours worked		Market Real GVA growth			Hours worked growth		
	1995	2004	1995	2004	1995-2000	2000-2004	1995-2004	1995-2000	2000-2004	1995-2004
Total market economy	100,00%	100,00%	100,00%	100,00%	4,16%	2,75%	3,53%	4,82%	1,59%	3,39%
Intensive ICT-users	**38,19%**	**38,66%**	**23,47%**	**22,77%**	**1,52%**	**1,25%**	**1,41%**	**0,95%**	**0,39%**	**0,71%**
Energy and water	2,71%	2,82%	0,75%	0,46%	0,09%	0,12%	0,11%	-0,01%	-0,01%	-0,01%
Pulp, paper, printing & publishing	0,75%	0,81%	0,84%	0,74%	0,06%	0,01%	0,03%	0,02%	0,01%	0,01%
Electric, electronic & optic equipment	0,57%	0,59%	0,48%	0,49%	0,04%	0,00%	0,02%	0,04%	-0,01%	0,02%
Transport and communications	8,94%	9,95%	7,34%	6,68%	0,46%	0,42%	0,45%	0,20%	0,12%	0,16%
Financial intermediation	5,27%	5,07%	2,74%	2,15%	0,13%	0,19%	0,16%	0,00%	0,03%	0,02%
Business services	14,72%	14,48%	5,90%	7,09%	0,57%	0,39%	0,49%	0,51%	0,16%	0,35%
Private health & social services	2,21%	2,19%	1,87%	1,86%	0,10%	0,05%	0,08%	0,09%	0,03%	0,06%
Other community, social & personal services	3,01%	2,75%	3,55%	3,31%	0,07%	0,07%	0,07%	0,11%	0,06%	0,09%
Non-Intensive ICT-users	**61,81%**	**61,34%**	**76,53%**	**77,23%**	**2,65%**	**1,50%**	**2,12%**	**3,88%**	**1,20%**	**2,68%**
Agriculture & cattle farming	9,58%	10,05%	14,34%	12,80%	0,75%	0,01%	0,40%	0,57%	-0,04%	0,29%
Fishing	0,47%	0,43%	0,65%	0,37%	0,02%	0,00%	0,01%	-0,02%	-0,01%	-0,01%
Mineral oil refining, coke & nuclear fuel	1,25%	1,15%	0,41%	0,36%	0,00%	0,07%	0,03%	0,01%	0,01%	0,01%
Food, drink and tobacco	4,62%	3,37%	4,04%	2,66%	-0,06%	0,07%	0,00%	-0,08%	0,00%	-0,04%
Textiles, clothing, leather and footwear	0,82%	0,68%	1,70%	1,24%	0,02%	0,00%	0,01%	0,01%	-0,01%	0,00%
Wood & products of wood & cork	0,30%	0,33%	0,71%	0,70%	0,03%	0,00%	0,01%	0,03%	0,02%	0,02%
Chemicals	1,24%	1,10%	0,66%	0,65%	0,04%	0,00%	0,03%	0,04%	0,00%	0,02%
Rubber & plastics	0,42%	0,51%	0,37%	0,37%	0,03%	0,03%	0,03%	0,01%	0,01%	0,01%
Other non-metallic mineral products	1,27%	1,47%	1,21%	1,16%	0,07%	0,07%	0,07%	0,05%	0,02%	0,03%
Fabricated metal products	1,49%	1,41%	1,63%	1,67%	0,05%	0,04%	0,04%	0,11%	0,00%	0,06%
Machinery & mechanical equipment	0,38%	0,63%	0,50%	0,54%	0,04%	0,05%	0,05%	0,02%	0,02%	0,02%
Transport equipment manufacturing	1,47%	1,26%	1,30%	1,11%	0,05%	0,00%	0,02%	0,04%	-0,01%	0,02%
Miscellaneous manufacturing	0,49%	0,59%	1,05%	1,10%	0,04%	0,02%	0,03%	0,09%	-0,01%	0,04%
Construction	10,53%	12,50%	11,88%	16,38%	0,48%	0,76%	0,63%	1,07%	0,82%	0,98%
Wholesale & retail trade; Repairs	17,58%	16,04%	26,05%	25,74%	0,60%	0,22%	0,42%	1,33%	0,25%	0,84%
Hotels and catering	8,31%	8,41%	8,62%	9,09%	0,44%	0,15%	0,31%	0,56%	0,11%	0,35%
Private education	1,58%	1,43%	1,41%	1,30%	0,05%	0,02%	0,04%	0,05%	0,02%	0,03%

Source: INE, IEA and own calculations

These results are extended in Table 8. Growth rates of the GVA and employment are calculated for the 25 market economy sectors, as well as the productivity growth and the level of labour productivity (aggregate productivity is normalized to 100). We then calculate simple averages over the two subgroups. Productivity growth and the level of productivity were on average higher in the ICT intensive sector. Such a difference increased during 2000-2004. In this sector, the level of productivity increased from 163.7 to 185.2, i.e. 13%, while in the non-intensive ICT sectors the increase was only 4.63%. Comparing both groups, productivity was 62% higher in the intensive ICT group during 1995-2000 and 76% higher for 2000-2004. Productivity performance in two sectors of the ICT intensive group was rather poor: "Pulp, paper, printing and publishing", and "Other community, social and personal services".[10]

[10] It should be noticed that both averages of productivity levels (those of ICT and non-ICT sectors) are above 100 because they have not been obtained as a result of a sectoral weighting, but only a simple average.

Table 8: GVA, employment (hours worked) and labour productivity.

	Market GVA growth			Employment growth			Productivity growth			Productivity level		
	95-00	00-04	95-04	95-00	00-04	95-04	95-00	00-04	95-04	1995	2000	2004
Total market economy	4,16%	2,75%	3,53%	4,82%	1,59%	3,39%	-0,66%	1,16%	0,14%	100,0	100,0	100,0
Intensive ICT-users												
Energy and water	3,46%	4,59%	3,96%	-2,32%	-1,77%	-2,08%	5,79%	6,36%	6,04%	354,4	488,2	604,7
Pulp, paper, printing & publishing	6,98%	1,09%	4,36%	2,51%	1,03%	1,85%	4,47%	0,06%	2,51%	87,2	112,4	108,0
Electric, electronic & optic equipment	6,88%	0,12%	3,88%	7,60%	-1,11%	3,73%	-0,71%	1,23%	0,15%	117,5	116,9	117,7
Transport and communications	4,99%	4,39%	4,73%	2,82%	1,76%	2,35%	2,17%	2,63%	2,38%	119,2	137,1	144,9
Financial intermediation	2,62%	3,73%	3,11%	0,09%	1,46%	0,70%	2,52%	2,27%	2,41%	188,6	220,6	229,8
Business services	3,89%	2,67%	3,35%	7,91%	2,32%	5,42%	-4,02%	0,36%	-2,08%	244,3	206,0	198,7
Private health & social services	4,37%	2,27%	3,44%	4,69%	1,58%	3,31%	-0,31%	0,69%	0,13%	115,7	117,5	114,9
Other community, social & personal services	2,53%	2,51%	2,52%	3,21%	1,88%	2,62%	-0,68%	0,63%	-0,10%	83,1	82,8	80,8
Average	4,47%	2,67%	3,67%	3,31%	0,89%	2,24%	1,15%	1,78%	1,43%	163,7	185,2	199,9
Non-Intensive ICT-users												
Agriculture & cattle farming	7,26%	0,08%	4,07%	4,08%	-0,32%	2,13%	3,18%	0,40%	1,94%	65,4	79,1	81,2
Fishing	4,35%	0,77%	2,76%	-3,68%	-1,41%	-2,67%	8,03%	2,18%	5,43%	70,5	108,7	119,9
Mineral oil refining, coke & nuclear fuel	-0,39%	6,24%	2,56%	1,97%	1,67%	1,84%	-2,36%	4,58%	0,72%	297,9	273,0	315,0
Food, drink and tobacco	-1,54%	1,96%	0,02%	-2,30%	0,10%	-1,24%	0,77%	1,87%	1,26%	112,2	120,2	124,2
Textiles, clothing, leather and footwear	3,00%	-0,52%	1,43%	0,42%	-0,68%	-0,07%	2,58%	0,16%	1,51%	47,4	55,7	53,7
Wood & products of wood & cork	7,86%	0,64%	4,65%	3,78%	2,45%	3,19%	4,08%	-1,81%	1,46%	41,4	52,4	46,7
Chemicals	3,62%	0,43%	2,20%	5,57%	0,32%	3,24%	-1,95%	0,11%	-1,04%	184,2	172,3	165,9
Rubber & plastics	5,91%	5,57%	5,76%	2,48%	4,11%	3,20%	3,44%	1,46%	2,56%	110,7	135,6	137,8
Other non-metallic mineral products	5,49%	4,64%	5,11%	3,81%	1,82%	2,92%	1,68%	2,82%	2,19%	102,6	115,1	123,5
Fabricated metal products	3,12%	2,60%	2,89%	6,68%	-0,11%	3,66%	-3,55%	2,71%	-0,77%	89,9	77,6	82,9
Machinery & mechanical equipment	9,58%	8,20%	8,97%	4,77%	3,20%	4,07%	4,82%	4,99%	4,89%	74,6	97,9	114,5
Transport equipment manufacturing	3,35%	-0,12%	1,81%	3,28%	-0,50%	1,60%	0,07%	0,38%	0,21%	110,7	114,6	111,5
Miscellaneous manufacturing	7,54%	3,12%	5,57%	7,76%	-0,93%	3,90%	-0,23%	4,05%	1,67%	46,1	47,0	53,0
Construction	4,55%	6,54%	5,43%	8,21%	5,39%	6,96%	-3,66%	1,15%	-1,52%	86,8	74,6	72,2
Wholesale & retail trade; Repairs	3,46%	1,33%	2,51%	5,09%	0,96%	3,26%	-1,63%	0,36%	-0,75%	66,1	62,8	60,6
Hotels and catering	5,18%	1,76%	3,66%	6,24%	1,15%	3,98%	-1,06%	0,61%	-0,31%	94,5	92,4	90,1
Private education	3,02%	1,67%	2,42%	3,44%	1,42%	2,54%	-0,42%	0,24%	-0,13%	110,0	111,1	106,6
Average	4,43%	2,64%	3,64%	3,62%	1,10%	2,50%	0,81%	1,55%	1,14%	100,6	105,3	109,4

Source: INE, IEA and own calculations

Tables 9.a to 9.f present the structural decomposition proposed in Section 2 applied to the 25 market sectors. Tables 9.a and b refer to the intensive ICT sectors and the remaining tables refer to the non intensive ones. Calculation of output-input growth rates, cost shares, and the contributions to growth and productivity are presented. Before commenting these results, an important caveat should be carried in mind when executing this analysis: the exercise is based upon a primary and approximate data source and some possible mistakes may arise. For instance, sectoral series of the different capital assets are extrapolations from the national series estimated by Mas and Quesada (2005). Second, data for years 2003 and 2004 are based on ARIMA projections. Third, the human capital index could only be disaggregated in 10 groups of the 25 market economy sectors. This can be biasing the contribution of each asset to growth and productivity.

Taking into account these drawbacks, from this collection of tables we highlight the following results. First, the most important impact of ICT on both GVA growth and productivity growth is observed in some of the intensive ICT sectors, mainly "Electric, electronic & optic equipment", "Transport & communications", "Financial intermediation", "Business services", "Private health" and "Other community services". With the important exception of "Electric, electronic & optic equipment", they all belong to the service sector. The contribution of ICT to growth exceeded those of non ICT assets. As we have seen from Tables 7 and 8, the level of productivity was remarkably higher in these intensive ICT sectors. Also, the fraction of market GVA growth accounted by the intensive ICT sectors has been increasing with time. Intensive ICT sectors responded by a 0.45% from each 1% of market GVA growth in period 2000-2004.

In the financial intermediation sector, as a prominent example, the contribution of ICT to growth doubled that of the non-ICT assets in the second period. According to this decomposition, the positive productivity growth in this sector was due to investment on hardware and software, mainly, and to a lesser extent on communication networks. The role of hardware was higher than software during the first period, 1995-2000. However, this dominance reversed during the second period. Yet a considerable source of growth in this sector should be associated to human capital accumulation. These results widely reflect the dynamism shown by the Spanish banking and financial industry during the last ten years.

In these intensive ICT sectors, the contribution of hours worked to growth is also a remarkable one. This contribution was higher than that of ICT in most of these sectors and for most of the periods ("Financial intermediation" is an important exception to this rule).

As a conclusion, the order of dominance in these decompositions can be written as follows:

L > ICT > non-ICT

This means that ICT is already an important contributor to GVA growth and productivity growth in these ICT intensive sectors but, in general, not so much as the labour input. A different pattern is found for the non-intensive ICT sectors. ICT have a negligible impact on growth and productivity in most of the ICT non-intensive sectors.

The labour input is found to be the main contributor of growth in most of these sectors. As we observed from Table 3, human capital accumulation is now lower, and its contribution to growth is small when compared to that of total hours worked. "Chemicals" and "Machinery & mechanical equipment" are two exceptions to this pattern.

Two paradigmatic cases are "Construction" and "Wholesale & retail trade". They together accumulated about a 40% of total employment and about a 30% of total market GVA in 2004. In both sectors, labour is by no doubt the main source of growth. Productivity growth is negative during the first period, positive in the second one, but negative on average from 1995 to 2004. In "Construction", the effect of all asset types was negligible on the evolution of productivity growth. TFP is what matters in explaining productivity in this sector. On the contrary, non ICT capital assets explained most of labour productivity growth in the "Wholesale & retail trade" sector.

As a conclusion, attending to both GVA growth and productivity growth decompositions, the order of dominance in the ICT non intensive sectors can be written as follows:

L > ICT > non-ICT

Table 9.a: ICT-intensive sectors. Growth and productivity decomposition

		Energy and water			Pulp, paper, printing & publishing			Electric, electronic & optic equipment			Transport & communications		
		95-00	00-04	95-04	95-00	00-04	95-04	95-00	00-04	95-04	95-00	00-04	95-04
	Real GVA growth	3,46%	4,59%	3,96%	6,98%	1,09%	4,36%	6,88%	0,12%	3,88%	4,99%	4,39%	4,73%
Growth rates	Hours (HL)	-2,32%	-1,77%	-2,08%	2,51%	1,03%	1,85%	7,60%	-1,11%	3,73%	2,82%	1,76%	2,35%
	KH	0,23%	0,69%	0,44%	0,85%	0,91%	0,88%	0,45%	0,33%	0,40%	1,23%	1,19%	1,21%
	Constructions	6,76%	8,21%	7,40%	2,37%	6,27%	4,10%	6,13%	6,25%	6,18%	4,76%	7,96%	6,18%
	Transport equipments	6,78%	6,35%	6,59%	1,56%	3,69%	2,51%	0,15%	-0,25%	-0,03%	4,08%	5,52%	4,72%
	Machinery	3,72%	7,01%	5,18%	2,88%	5,54%	4,06%	4,49%	2,81%	3,74%	9,71%	6,60%	8,33%
	Communications	6,22%	7,11%	6,61%	6,49%	9,47%	7,82%	9,06%	6,22%	7,79%	8,72%	6,55%	7,76%
	Hardware	8,00%	25,48%	15,77%	13,95%	20,98%	17,08%	22,41%	20,99%	21,78%	45,02%	19,68%	33,76%
	Software	25,25%	5,48%	16,46%	14,49%	14,35%	14,43%	26,10%	18,46%	22,70%	18,89%	17,21%	18,14%
Cost shares	Labor	0,5041	0,4457	0,4780	0,7147	0,7291	0,7187	0,7644	0,7694	0,7648	0,5597	0,5236	0,5426
	Constructions	0,1441	0,1542	0,1503	0,0619	0,0506	0,0581	0,0342	0,0311	0,0335	0,1000	0,0821	0,0936
	Transport equipments	0,0059	0,0083	0,0069	0,0085	0,0092	0,0088	0,0039	0,0037	0,0038	0,1775	0,1936	0,1847
	Machinery	0,3049	0,3412	0,3198	0,1734	0,1716	0,1734	0,1440	0,1391	0,1421	0,0165	0,0185	0,0174
	Communications	0,0277	0,0307	0,0287	0,0163	0,0177	0,0169	0,0123	0,0131	0,0126	0,1130	0,1186	0,1148
	Hardware	0,0070	0,0043	0,0059	0,0223	0,0150	0,0193	0,0392	0,0373	0,0393	0,0062	0,0091	0,0074
	Software	0,0064	0,0155	0,0104	0,0029	0,0067	0,0047	0,0019	0,0062	0,0039	0,0271	0,0544	0,0395
Contribution to growth	Hours (HL)	-1,17%	-0,79%	-0,99%	1,79%	0,75%	1,33%	5,81%	-0,85%	2,85%	1,58%	0,92%	1,27%
	Non-ICT KP	2,15%	3,71%	2,82%	0,66%	1,30%	0,96%	0,86%	0,58%	0,74%	1,36%	1,84%	1,60%
	ICT KP	0,39%	0,41%	0,45%	0,46%	0,58%	0,53%	1,04%	0,98%	1,04%	1,78%	1,89%	1,86%
	Communications	0,17%	0,22%	0,19%	0,11%	0,17%	0,13%	0,11%	0,08%	0,10%	0,99%	0,78%	0,89%
	Hardware	0,06%	0,11%	0,09%	0,31%	0,31%	0,33%	0,88%	0,78%	0,86%	0,28%	0,18%	0,25%
	Software	0,16%	0,09%	0,17%	0,04%	0,10%	0,07%	0,05%	0,12%	0,09%	0,51%	0,94%	0,72%
Contribution to Productivity	Productivity growth	5,79%	6,36%	6,04%	4,47%	0,06%	2,51%	-0,71%	1,23%	0,15%	2,17%	2,63%	2,38%
	Non-ICT KP	3,20%	4,60%	3,81%	0,05%	1,06%	0,52%	-0,53%	0,78%	0,07%	0,53%	1,33%	0,90%
	ICT KP	0,48%	0,50%	0,55%	0,36%	0,54%	0,45%	0,64%	1,04%	0,83%	1,36%	1,57%	1,48%
	Communications	0,24%	0,27%	0,25%	0,06%	0,15%	0,10%	0,02%	0,10%	0,05%	0,67%	0,57%	0,62%
	Hardware	0,07%	0,12%	0,10%	0,26%	0,30%	0,29%	0,58%	0,82%	0,71%	0,26%	0,16%	0,23%
	Software	0,18%	0,11%	0,19%	0,04%	0,09%	0,06%	0,04%	0,12%	0,07%	0,44%	0,84%	0,62%
	KH	0,12%	0,31%	0,21%	0,61%	0,66%	0,63%	0,34%	0,26%	0,30%	0,69%	0,63%	0,66%
	TFP	1,98%	0,94%	1,48%	3,46%	-2,20%	0,91%	-1,16%	-0,85%	-1,06%	-0,41%	-0,89%	-0,66%

Source: INE, IEA, Mas and Quesada (2005) and own calculations

Table 9.b: ICT-intensive sectors. Growth and productivity decomposition

		Financial intermediation			Business services			Private health & social services			Other community, social & personal services		
		95-00	00-04	95-04	95-00	00-04	95-04	95-00	00-04	95-04	95-00	00-04	95-04
	Real GVA growth	2,62%	3,73%	3,11%	3,89%	2,67%	3,35%	4,37%	2,27%	3,44%	2,53%	2,51%	2,52%
Growth rates	Hours (HL)	0,09%	1,46%	0,70%	7,91%	2,32%	5,42%	4,69%	1,58%	3,31%	3,21%	1,88%	2,62%
	KH	1,60%	0,13%	0,94%	1,60%	0,13%	0,94%	0,39%	0,37%	0,38%	0,39%	0,37%	0,38%
	Constructions	0,10%	6,09%	2,76%	10,51%	10,26%	10,40%	9,28%	8,97%	9,15%	9,72%	8,55%	9,20%
	Transport equipments	10,92%	8,77%	9,96%	13,12%	10,17%	11,81%	10,95%	6,35%	8,91%	9,11%	3,40%	6,57%
	Machinery	10,88%	12,18%	11,46%	9,85%	6,94%	8,56%	7,47%	5,78%	6,72%	2,54%	-1,09%	0,93%
	Communications	6,43%	11,05%	8,49%	18,98%	14,28%	16,89%	14,12%	10,96%	12,71%	4,40%	7,66%	5,85%
	Hardware	15,63%	17,88%	16,63%	26,79%	16,71%	22,31%	30,40%	22,28%	26,79%	27,61%	17,08%	22,93%
	Software	8,55%	13,97%	10,96%	7,59%	4,09%	6,04%	13,68%	9,38%	11,77%	8,02%	4,69%	6,54%
Cost shares	Labor	0,7892	0,7685	0,7786	0,7164	0,6780	0,6992	0,8856	0,8928	0,8887	0,7610	0,7530	0,7573
	Constructions	0,0417	0,0304	0,0373	0,0222	0,0197	0,0214	0,0226	0,0196	0,0217	0,0532	0,0563	0,0554
	Transport equipments	0,0044	0,0066	0,0054	0,0630	0,0828	0,0716	0,0015	0,0018	0,0016	0,0305	0,0404	0,0348
	Machinery	0,0430	0,0597	0,0505	0,0968	0,0942	0,0953	0,0660	0,0605	0,0635	0,0454	0,0386	0,0420
	Communications	0,0050	0,0053	0,0051	0,0126	0,0170	0,0144	0,0017	0,0019	0,0018	0,0809	0,0769	0,0789
	Hardware	0,0506	0,0334	0,0433	0,0378	0,0296	0,0341	0,0165	0,0157	0,0160	0,0155	0,0157	0,0155
	Software	0,0662	0,0962	0,0799	0,0425	0,0467	0,0448	0,0060	0,0077	0,0067	0,0136	0,0191	0,0162
Contribution to growth	Hours (HL)	0,07%	1,12%	0,54%	5,67%	1,57%	3,79%	4,15%	1,41%	2,94%	2,44%	1,41%	1,98%
	Non-ICT KP	0,52%	0,97%	0,74%	2,01%	1,70%	1,88%	0,72%	0,54%	0,64%	0,91%	0,58%	0,78%
	ICT KP	1,39%	2,00%	1,64%	1,57%	0,93%	1,28%	0,61%	0,44%	0,53%	0,89%	0,95%	0,92%
	Communications	0,03%	0,06%	0,04%	0,24%	0,24%	0,24%	0,02%	0,02%	0,02%	0,36%	0,59%	0,46%
	Hardware	0,79%	0,60%	0,72%	1,01%	0,49%	0,76%	0,50%	0,35%	0,43%	0,43%	0,27%	0,36%
	Software	0,57%	1,34%	0,87%	0,32%	0,19%	0,27%	0,08%	0,07%	0,08%	0,11%	0,09%	0,11%
Contribution to Productivity	Productivity growth	2,52%	2,27%	2,41%	-4,02%	0,36%	-2,08%	-0,31%	0,69%	0,13%	-0,68%	0,63%	-0,10%
	Non-ICT KP	0,51%	0,83%	0,67%	0,57%	1,24%	0,86%	0,30%	0,41%	0,35%	0,50%	0,32%	0,43%
	ICT KP	1,38%	1,80%	1,55%	0,84%	0,71%	0,77%	0,49%	0,40%	0,45%	0,54%	0,74%	0,63%
	Communications	0,03%	0,05%	0,04%	0,14%	0,20%	0,17%	0,02%	0,02%	0,02%	0,10%	0,44%	0,25%
	Hardware	0,79%	0,55%	0,69%	0,71%	0,43%	0,58%	0,42%	0,32%	0,38%	0,38%	0,24%	0,32%
	Software	0,56%	1,20%	0,82%	-0,01%	0,08%	0,03%	0,05%	0,06%	0,06%	0,07%	0,05%	0,06%
	KH	1,26%	0,10%	0,73%	1,14%	0,09%	0,66%	0,35%	0,33%	0,34%	0,30%	0,28%	0,29%
	TFP	-0,63%	-0,46%	-0,54%	-6,51%	-1,61%	-4,26%	-1,46%	-0,45%	-1,01%	-2,01%	-0,70%	-1,45%

Source: INE, IEA, Mas and Quesada (2005) and own calculations

Table 9.c: ICT Non-intensive sectors. Growth and productivity decomposition

		Agriculture & cattle farming			Fishing			Mineral oil refining, coke & nuclear fuel			Food, drink and tobacco			Textiles, clothing, leather & footwear		
		95-00	00-04	95-04	95-00	00-04	95-04	95-00	00-04	95-04	95-00	00-04	95-04	95-00	00-04	95-04
	Real GVA growth	7,26%	0,08%	4,07%	4,35%	0,77%	2,76%	-0,39%	6,24%	2,56%	-1,54%	1,96%	0,02%	3,00%	-0,52%	1,43%
Growth rates	Hours (HL)	4,08%	-0,32%	2,13%	-3,68%	-1,41%	-2,67%	1,97%	1,67%	1,84%	-2,30%	0,10%	-1,24%	0,42%	-0,68%	-0,07%
	KH	0,66%	0,46%	0,57%	0,66%	0,46%	0,57%	0,23%	0,69%	0,44%	0,85%	0,91%	0,88%	0,85%	0,91%	0,88%
	Constructions	3,26%	4,94%	4,01%	-0,57%	-1,67%	-1,06%	6,90%	7,95%	7,37%	1,97%	2,14%	2,05%	0,55%	3,01%	1,65%
	Transport equipments	1,15%	3,33%	2,12%	-1,55%	-2,40%	-1,93%	4,15%	5,94%	4,95%	1,00%	-2,40%	-0,51%	0,01%	-0,42%	-0,18%
	Machinery	2,24%	3,68%	2,88%	-11,13%	-10,68%	-10,93%	3,16%	5,41%	4,16%	1,83%	1,05%	1,48%	-0,24%	1,46%	0,51%
	Communications	6,42%	11,64%	8,74%	15,93%	9,34%	13,00%	6,23%	9,46%	7,66%	5,40%	4,97%	5,21%	3,54%	5,94%	4,61%
	Hardware	46,36%	23,19%	36,06%	26,39%	16,30%	21,90%	22,19%	17,37%	20,05%	16,87%	13,44%	15,35%	16,00%	9,08%	12,92%
	Software	24,75%	-2,32%	12,72%	9,60%	-8,07%	1,75%	29,05%	9,51%	20,37%	13,57%	4,68%	9,62%	19,18%	8,86%	14,59%
Cost shares	Labor	0,6960	0,7121	0,7015	0,4120	0,4137	0,4141	0,6401	0,6358	0,6380	0,6490	0,6362	0,6441	0,8273	0,8358	0,8302
	Constructions	0,1179	0,1024	0,1128	0,0569	0,0434	0,0516	0,0993	0,0891	0,0959	0,1162	0,1076	0,1136	0,0394	0,0334	0,0375
	Transport equipments	0,0124	0,0137	0,0130	0,5066	0,5223	0,5116	0,0199	0,0246	0,0219	0,0196	0,0231	0,0209	0,0102	0,0111	0,0106
	Machinery	0,1732	0,1712	0,1722	0,0178	0,0103	0,0145	0,2148	0,2187	0,2157	0,1789	0,1924	0,1835	0,1058	0,1021	0,1043
	Communications	0,0005	0,0006	0,0006	0,0052	0,0085	0,0066	0,0192	0,0234	0,0210	0,0169	0,0197	0,0180	0,0096	0,0103	0,0099
	Hardware	0,0000	0,0000	0,0000	0,0008	0,0010	0,0009	0,0050	0,0039	0,0045	0,0152	0,0132	0,0142	0,0069	0,0052	0,0062
	Software	0,0000	0,0000	0,0000	0,0007	0,0008	0,0007	0,0016	0,0047	0,0030	0,0042	0,0078	0,0057	0,0009	0,0021	0,0014
Contribution to growth	Hours (HL)	2,84%	-0,23%	1,49%	-1,52%	-0,58%	-1,11%	1,26%	1,06%	1,17%	-1,50%	0,06%	-0,80%	0,35%	-0,57%	-0,06%
	Non-ICT KP	0,79%	1,18%	0,98%	-1,02%	-1,44%	-1,20%	1,45%	2,04%	1,71%	0,58%	0,38%	0,49%	0,00%	0,24%	0,11%
	ICT KP	0,00%	0,01%	0,01%	0,11%	0,09%	0,11%	0,28%	0,33%	0,31%	0,41%	0,31%	0,37%	0,16%	0,13%	0,15%
	Communications	0,00%	0,01%	0,00%	0,08%	0,08%	0,09%	0,12%	0,22%	0,16%	0,09%	0,10%	0,09%	0,03%	0,06%	0,05%
	Hardware	0,00%	0,00%	0,00%	0,02%	0,02%	0,02%	0,11%	0,07%	0,09%	0,26%	0,18%	0,22%	0,11%	0,05%	0,08%
	Software	0,00%	0,00%	0,00%	0,01%	-0,01%	0,00%	0,05%	0,04%	0,06%	0,06%	0,04%	0,06%	0,02%	0,02%	0,02%
Contribution to Productivity	Productivity growth	3,18%	0,40%	1,94%	8,03%	2,18%	5,43%	-2,36%	4,58%	0,72%	0,77%	1,87%	1,26%	2,58%	0,16%	1,51%
	Non-ICT KP	-0,45%	1,27%	0,34%	1,12%	-0,63%	0,34%	0,79%	1,48%	1,10%	1,30%	0,35%	0,89%	-0,07%	0,34%	0,12%
	ICT KP	0,00%	0,01%	0,00%	0,13%	0,10%	0,13%	0,23%	0,28%	0,26%	0,49%	0,31%	0,41%	0,15%	0,14%	0,15%
	Communications	0,00%	0,01%	0,00%	0,10%	0,09%	0,10%	0,08%	0,18%	0,12%	0,13%	0,10%	0,12%	0,03%	0,07%	0,05%
	Hardware	0,00%	0,00%	0,00%	0,02%	0,02%	0,02%	0,10%	0,06%	0,08%	0,29%	0,18%	0,24%	0,11%	0,05%	0,08%
	Software	0,00%	0,00%	0,00%	0,01%	-0,01%	0,00%	0,04%	0,04%	0,05%	0,07%	0,04%	0,06%	0,02%	0,02%	0,02%
	KH	0,46%	0,33%	0,40%	0,27%	0,19%	0,24%	0,15%	0,44%	0,28%	0,55%	0,58%	0,56%	0,71%	0,76%	0,73%
	TFP	3,17%	-1,21%	1,20%	6,50%	2,51%	4,73%	-3,53%	2,37%	-0,92%	-1,57%	0,64%	-0,61%	1,79%	-1,08%	0,51%

Source: INE, IEA, Mas and Quesada (2005) and own calculations

Table 9.d: ICT Non-intensive sectors. Growth and productivity decomposition

		Wood & products of wood & cork			Chemicals			Rubber & plastics			Other non-metallic mineral products			Fabricated metal products		
		95-00	00-04	95-04	95-00	00-04	95-04	95-00	00-04	95-04	95-00	00-04	95-04	95-00	00-04	95-04
	Real GVA growth	7,86%	0,64%	4,65%	3,62%	0,43%	2,20%	5,91%	5,57%	5,76%	5,49%	4,64%	5,11%	3,12%	2,60%	2,89%
Growth rates	Hours (HL)	3,78%	2,45%	3,19%	5,57%	0,32%	3,24%	2,48%	4,11%	3,20%	3,81%	1,82%	2,92%	6,68%	-0,11%	3,66%
	KH	0,85%	0,91%	0,88%	0,23%	0,69%	0,44%	0,23%	0,69%	0,44%	0,23%	0,69%	0,44%	0,23%	0,69%	0,44%
	Constructions	7,63%	6,64%	7,19%	2,55%	0,97%	1,85%	7,03%	4,67%	5,98%	5,56%	4,31%	5,00%	7,99%	8,22%	8,09%
	Transport equipments	6,09%	5,88%	6,00%	2,74%	-3,54%	-0,05%	5,31%	-2,11%	2,01%	2,64%	2,04%	2,38%	7,01%	8,66%	7,74%
	Machinery	7,33%	6,52%	6,97%	1,80%	-1,02%	0,55%	6,62%	2,71%	4,89%	4,25%	2,33%	3,40%	6,79%	7,57%	7,14%
	Communications	11,58%	10,27%	11,00%	6,24%	4,24%	5,35%	10,73%	7,96%	9,50%	8,42%	8,10%	8,28%	10,34%	11,54%	10,87%
	Hardware	15,19%	23,39%	18,83%	14,97%	8,49%	12,09%	23,54%	14,45%	19,50%	16,56%	17,36%	16,92%	25,14%	30,35%	27,46%
	Software	6,36%	30,35%	17,03%	17,94%	-5,25%	7,63%	17,74%	1,23%	10,40%	15,71%	12,21%	14,15%	29,05%	18,64%	24,42%
Cost shares	Labor	0,7775	0,7808	0,7773	0,6887	0,7193	0,7008	0,8373	0,8550	0,8459	0,6486	0,6659	0,6563	0,5371	0,5387	0,5337
	Constructions	0,0679	0,0584	0,0648	0,0974	0,0794	0,0910	0,0457	0,0363	0,0419	0,0881	0,0755	0,0836	0,1718	0,1541	0,1669
	Transport equipments	0,0177	0,0204	0,0190	0,0117	0,0127	0,0121	0,0060	0,0059	0,0059	0,0235	0,0253	0,0242	0,0149	0,0186	0,0167
	Machinery	0,1196	0,1225	0,1211	0,1694	0,1574	0,1641	0,0950	0,0875	0,0908	0,2099	0,2026	0,2056	0,2422	0,2480	0,2456
	Communications	0,0109	0,0126	0,0117	0,0155	0,0164	0,0159	0,0089	0,0093	0,0089	0,0188	0,0209	0,0196	0,0220	0,0245	0,0231
	Hardware	0,0057	0,0038	0,0050	0,0140	0,0091	0,0119	0,0063	0,0045	0,0054	0,0095	0,0067	0,0083	0,0104	0,0109	0,0108
	Software	0,0008	0,0015	0,0011	0,0033	0,0056	0,0043	0,0009	0,0015	0,0011	0,0016	0,0031	0,0023	0,0016	0,0052	0,0033
Contribution to to growth	Hours (HL)	2,94%	1,91%	2,48%	3,84%	0,23%	2,27%	2,08%	3,51%	2,71%	2,47%	1,21%	1,92%	3,59%	-0,06%	1,95%
	Non-ICT KP	1,50%	1,31%	1,42%	0,59%	-0,13%	0,26%	0,98%	0,39%	0,71%	1,44%	0,85%	1,17%	3,12%	3,31%	3,23%
	ICT KP	0,22%	0,26%	0,24%	0,37%	0,12%	0,26%	0,26%	0,14%	0,20%	0,34%	0,32%	0,34%	0,54%	0,71%	0,63%
	Communications	0,13%	0,13%	0,13%	0,10%	0,07%	0,08%	0,10%	0,07%	0,09%	0,16%	0,17%	0,16%	0,23%	0,28%	0,25%
	Hardware	0,09%	0,09%	0,09%	0,21%	0,08%	0,14%	0,15%	0,06%	0,11%	0,16%	0,12%	0,14%	0,26%	0,33%	0,30%
	Software	0,00%	0,05%	0,02%	0,06%	-0,03%	0,03%	0,02%	0,00%	0,01%	0,03%	0,04%	0,03%	0,05%	0,10%	0,08%
Contribution to Productivity	Productivity growth	4,08%	-1,81%	1,46%	-1,95%	0,11%	-1,04%	3,44%	1,46%	2,56%	1,68%	2,82%	2,19%	-3,55%	2,71%	-0,77%
	Non-ICT KP	0,73%	0,81%	0,77%	-0,97%	-0,21%	-0,61%	0,62%	-0,14%	0,26%	0,22%	0,30%	0,26%	0,26%	3,35%	1,66%
	ICT KP	0,15%	0,22%	0,18%	0,18%	0,11%	0,16%	0,22%	0,08%	0,15%	0,23%	0,27%	0,25%	0,31%	0,71%	0,49%
	Communications	0,09%	0,10%	0,09%	0,01%	0,06%	0,03%	0,07%	0,04%	0,06%	0,09%	0,13%	0,11%	0,08%	0,28%	0,17%
	Hardware	0,07%	0,08%	0,08%	0,13%	0,07%	0,11%	0,13%	0,05%	0,09%	0,12%	0,10%	0,12%	0,19%	0,33%	0,26%
	Software	0,00%	0,04%	0,02%	0,04%	-0,03%	0,02%	0,01%	0,00%	0,01%	0,02%	0,03%	0,03%	0,04%	0,10%	0,07%
	KH	0,66%	0,71%	0,68%	0,16%	0,50%	0,31%	0,19%	0,59%	0,37%	0,15%	0,46%	0,29%	0,12%	0,37%	0,23%
	TFP	2,54%	-3,55%	-0,17%	-1,33%	-0,29%	-0,89%	2,41%	0,93%	1,78%	1,08%	1,80%	1,40%	-4,24%	-1,73%	-3,15%

Source: INE, IEA, Mas and Quesada (2005) and own calculations

Table 9.e: ICT Non-intensive sectors. Growth and productivity decomposition

		Machinery & mechanical equipment			Transport equipment manufacturing			Miscellaneous manufacturing			Construction			Wholesale & retail trade; Repairs		
		95-00	00-04	95-04	95-00	00-04	95-04	95-00	00-04	95-04	95-00	00-04	95-04	95-00	00-04	95-04
	Real GVA growth	9,58%	8,20%	8,97%	3,35%	-0,12%	1,81%	7,54%	3,12%	5,57%	4,55%	6,54%	5,43%	3,46%	1,33%	2,51%
Growth rates	Hours (HL)	4,77%	3,20%	4,07%	3,28%	-0,50%	1,60%	7,76%	-0,93%	3,90%	8,21%	5,39%	6,96%	5,09%	0,96%	3,26%
	KH	0,45%	0,33%	0,40%	0,45%	0,33%	0,40%	0,45%	0,33%	0,40%	0,57%	0,27%	0,44%	0,91%	0,56%	0,75%
	Constructions	0,66%	-0,40%	0,19%	4,31%	7,58%	5,76%	6,50%	4,84%	5,76%	4,75%	5,31%	5,00%	7,43%	6,61%	7,07%
	Transport equipments	1,42%	-2,40%	-0,28%	2,69%	2,67%	2,68%	5,99%	1,03%	3,79%	5,48%	5,69%	5,57%	7,22%	3,23%	5,45%
	Machinery	1,83%	-0,79%	0,67%	5,33%	7,61%	6,34%	6,07%	3,59%	4,96%	5,63%	5,39%	5,52%	4,27%	3,32%	3,85%
	Communications	5,64%	4,57%	5,16%	8,65%	10,77%	9,59%	10,83%	9,15%	10,08%	23,97%	17,63%	21,15%	15,57%	10,56%	13,34%
	Hardware	13,90%	7,08%	10,86%	22,23%	27,64%	24,63%	22,13%	17,55%	20,09%	25,18%	16,51%	21,33%	26,54%	19,01%	23,19%
	Software	23,32%	2,21%	13,93%	21,93%	10,77%	16,97%	24,59%	12,44%	19,19%	6,43%	3,65%	5,19%	8,67%	8,58%	8,63%
Cost shares	Labor	0,8520	0,8973	0,8719	0,7644	0,7188	0,7424	0,8327	0,8309	0,8313	0,9216	0,9383	0,9285	0,8453	0,8411	0,8422
	Constructions	0,0330	0,0189	0,0272	0,0290	0,0282	0,0293	0,0384	0,0340	0,0371	0,0383	0,0261	0,0334	0,0701	0,0668	0,0697
	Transport equipments	0,0121	0,0099	0,0111	0,0552	0,0670	0,0607	0,0094	0,0109	0,0100	0,0078	0,0079	0,0078	0,0145	0,0180	0,0160
	Machinery	0,0821	0,0597	0,0720	0,1310	0,1584	0,1439	0,1008	0,1033	0,1018	0,0296	0,0254	0,0277	0,0493	0,0473	0,0483
	Communications	0,0077	0,0062	0,0070	0,0122	0,0158	0,0139	0,0092	0,0110	0,0100	0,0000	0,0000	0,0000	0,0040	0,0053	0,0046
	Hardware	0,0120	0,0057	0,0093	0,0065	0,0072	0,0069	0,0083	0,0069	0,0077	0,0018	0,0014	0,0016	0,0095	0,0097	0,0097
	Software	0,0012	0,0022	0,0016	0,0017	0,0045	0,0030	0,0012	0,0030	0,0020	0,0009	0,0010	0,0009	0,0073	0,0117	0,0095
Contribution to growth	Hours (HL)	4,06%	2,88%	3,55%	2,50%	-0,36%	1,19%	6,46%	-0,77%	3,24%	7,57%	5,05%	6,46%	4,30%	0,81%	2,74%
	Non-ICT KP	0,19%	-0,08%	0,05%	0,97%	1,60%	1,24%	0,92%	0,55%	0,76%	0,39%	0,32%	0,36%	0,84%	0,66%	0,77%
	ICT KP	0,24%	0,07%	0,16%	0,29%	0,42%	0,35%	0,31%	0,26%	0,29%	0,05%	0,03%	0,04%	0,38%	0,34%	0,37%
	Communications	0,04%	0,03%	0,04%	0,11%	0,17%	0,13%	0,10%	0,10%	0,10%	0,00%	0,00%	0,00%	0,06%	0,06%	0,06%
	Hardware	0,17%	0,04%	0,10%	0,14%	0,20%	0,17%	0,18%	0,12%	0,16%	0,05%	0,02%	0,03%	0,25%	0,18%	0,22%
	Software	0,03%	0,00%	0,02%	0,04%	0,05%	0,05%	0,03%	0,04%	0,04%	0,01%	0,00%	0,00%	0,06%	0,10%	0,08%
Contribution to Productivity	Productivity growth	4,82%	4,99%	4,89%	0,07%	0,38%	0,21%	-0,23%	4,05%	1,67%	-3,66%	1,15%	-1,52%	-1,63%	0,36%	-0,75%
	Non-ICT KP	-0,42%	-0,36%	-0,40%	0,27%	1,73%	0,87%	-0,24%	0,68%	0,18%	-0,23%	0,00%	-0,12%	0,16%	0,53%	0,33%
	ICT KP	0,14%	0,03%	0,09%	0,22%	0,43%	0,32%	0,17%	0,28%	0,22%	0,03%	0,01%	0,02%	0,27%	0,32%	0,29%
	Communications	0,01%	0,01%	0,01%	0,07%	0,18%	0,11%	0,03%	0,11%	0,06%	0,00%	0,00%	0,00%	0,04%	0,05%	0,05%
	Hardware	0,11%	0,02%	0,06%	0,12%	0,20%	0,16%	0,12%	0,13%	0,13%	0,03%	0,02%	0,02%	0,20%	0,18%	0,19%
	Software	0,02%	0,00%	0,02%	0,03%	0,05%	0,05%	0,02%	0,04%	0,03%	0,00%	0,00%	0,00%	0,03%	0,09%	0,05%
	KH	0,38%	0,30%	0,35%	0,34%	0,24%	0,30%	0,37%	0,28%	0,33%	0,53%	0,25%	0,41%	0,77%	0,47%	0,63%
	TFP	4,71%	5,03%	4,86%	-0,76%	-2,02%	-1,27%	-0,53%	2,81%	0,95%	-3,99%	0,89%	-1,84%	-2,83%	-0,95%	-2,00%

Source: INE, IEA, Mas and Quesada (2005) and own calculations

Table 9.f: ICT Non-intensive sectors. Growth and productivity decomposition

		Hotels and catering			Private education		
		95-00	00-04	95-04	95-00	00-04	95-04
	Real GVA growth	5,18%	1,76%	3,66%	3,02%	1,67%	2,42%
Growth rates	Hours (HL)	6,24%	1,15%	3,98%	3,44%	1,42%	2,54%
	KH	0,91%	0,56%	0,75%	0,39%	0,37%	0,38%
	Constructions	7,72%	6,48%	7,17%	6,15%	8,99%	7,41%
	Transport equipments	4,55%	0,29%	2,66%	13,39%	12,71%	13,09%
	Machinery	2,77%	0,27%	1,66%	5,79%	8,21%	6,87%
	Communications	13,35%	11,76%	12,65%	11,48%	15,88%	13,44%
	Hardware	25,40%	15,94%	21,20%	31,93%	30,82%	31,44%
	Software	4,31%	-0,68%	2,09%	16,47%	15,46%	16,02%
Cost shares	Labor	0,8742	0,8960	0,8828	0,9500	0,9514	0,9500
	Constructions	0,0481	0,0405	0,0456	0,0326	0,0282	0,0312
	Transport equipments	0,0020	0,0020	0,0020	0,0020	0,0032	0,0025
	Machinery	0,0655	0,0508	0,0591	0,0106	0,0105	0,0106
	Communications	0,0047	0,0056	0,0051	0,0012	0,0014	0,0013
	Hardware	0,0024	0,0020	0,0022	0,0026	0,0034	0,0030
	Software	0,0031	0,0031	0,0031	0,0010	0,0018	0,0013
Contribution to growth	Hours (HL)	5,46%	1,03%	3,51%	3,27%	1,35%	2,42%
	Non-ICT KP	0,56%	0,28%	0,43%	0,29%	0,38%	0,34%
	ICT KP	0,14%	0,10%	0,12%	0,11%	0,16%	0,13%
	Communications	0,06%	0,07%	0,06%	0,01%	0,02%	0,02%
	Hardware	0,06%	0,03%	0,05%	0,08%	0,11%	0,09%
	Software	0,01%	0,00%	0,01%	0,02%	0,03%	0,02%
Contribution to Productivity	Productivity growth	-1,06%	0,61%	-0,31%	-0,42%	0,24%	-0,13%
	Non-ICT KP	-0,16%	0,17%	0,01%	0,13%	0,32%	0,22%
	ICT KP	0,07%	0,08%	0,08%	0,10%	0,15%	0,12%
	Communications	0,03%	0,06%	0,04%	0,01%	0,02%	0,01%
	Hardware	0,05%	0,03%	0,04%	0,08%	0,10%	0,09%
	Software	-0,01%	-0,01%	-0,01%	0,01%	0,03%	0,02%
	KH	0,79%	0,50%	0,66%	0,37%	0,35%	0,36%
	TFP	-1,76%	-0,14%	-1,06%	-1,03%	-0,57%	-0,83%

Source: INE, IEA, Mas and Quesada (2005) and own calculations

Finally, it should also be noticed that TFP growth was higher in the ICT non-intensive sectors than in the intensive ones. This is a very striking result, if we consider that TFP is associated to the efficiency by which a combination of inputs is used. Positive expansions in TFP imply that the same combination of resources can reach a higher level of output. Conversely, a contraction in TFP implies that firms must employ a higher combination of inputs to produce the same quantity of output. On the other hand, we have seen that productivity in the intensive ICT sectors is much higher than in the non intensive ones, and in ICT assets explain most of these increases in productivity. Hence, if these calculations are correct, the upsurge in productivity is due to a huge ICT capital accumulation that has overcome the efficiency losses in these ICT intensive sectors.

Table 10 collects all these results on TFP across periods. With the exception of "Energy and water", the rest of ICT intensive sectors presented a negative TFP growth in both periods. This was not the case in the ICT non-intensive sector where TFP growth improves in the second period and was higher to that of the intensive sector on average. We propose two complementary explanations to this striking result. First, these calculations might be affected by important measurement errors[11] and by several biasing problems.[12] This is a drawback that we mentioned at the beginning of this section. A second explanation is that the advantages associated to the use of ICT are not yet available. Efficiency gains require some time to blossom. This paradoxical result we obtain, however, is parallel to that obtained by Mas and Quesada (2006) for Spain.

[11] These disaggregated series are subject to important sampling errors.

[12] The over-qualification bias in the human capital index, or fixed effect biases due to aggregation of heterogeneous firms in some of the sectors.

Table 10: Total factor productivity growth.

Andalucía	95-00	00-04	95-04
Total market economy	-1,64%	-0,47%	-1,13%
Intensive ICT-users			
Energy and water	1,98%	0,94%	1,48%
Pulp, paper, printing & publishing	3,46%	-2,20%	0,91%
Electric, electronic & optic equipment	-1,16%	-0,85%	-1,06%
Transport and communications	-0,41%	-0,89%	-0,66%
Financial intermediation	-0,63%	-0,46%	-0,54%
Business services	-6,51%	-1,61%	-4,26%
Private health & social services	-1,46%	-0,45%	-1,01%
Other community, social & personal services	-2,01%	-0,70%	-1,45%
Average	-0,84%	-0,78%	-0,82%
Non-Intensive ICT-users			
Agriculture & cattle farming	3,17%	-1,21%	1,20%
Fishing	6,50%	2,51%	4,73%
Mineral oil refining, coke & nuclear fuel	-3,53%	2,37%	-0,92%
Food, drink and tobacco	-1,57%	0,64%	-0,61%
Textiles, clothing, leather and footwear	1,79%	-1,08%	0,51%
Wood & products of wood & cork	2,54%	-3,55%	-0,17%
Chemicals	-1,33%	-0,29%	-0,89%
Rubber & plastics	2,41%	0,93%	1,78%
Other non-metallic mineral products	1,08%	1,80%	1,40%
Fabricated metal products	-4,24%	-1,73%	-3,15%
Machinery & mechanical equipment	4,71%	5,03%	4,86%
Transport equipment manufacturing	-0,76%	-2,02%	-1,27%
Miscellaneous manufacturing	-0,53%	2,81%	0,95%
Construction	-3,99%	0,89%	-1,84%
Wholesale & retail trade; Repairs	-2,83%	-0,95%	-2,00%
Hotels and catering	-1,76%	-0,14%	-1,06%
Private education	-1,03%	-0,57%	-0,83%
Average	0,04%	0,32%	0,16%

Concluding remarks

The recent experiences of the US and some European countries show that ICT investment promotes economic growth and labour productivity. However, the European Union as a whole is still lagging behind the US in terms of ICT contribution to productivity. As a way of filling this gap, the Lisbon Strategy and the initiative i2010 included a number of policy recommendations that aimed to make significant advances on this issue.

Additionally, a number of economists have also claimed that the impact of ICT is sensitive to the existing economic structure and functioning of market for production factors, goods and services (see El País, 4 June 2006). Therefore, the use of new technologies should be viewed as an instrument for reversing productivity slowdown as long as they are properly combined with other policy measures such as the structural reforms promoted by the Lisbon Strategy.

The present study adopts a regional approach in order to consider the impact of ICT on productivity growth. It provides some quantitative results on the impact of ICT on economic growth in Andalucía over the period 1995-2004. It should be remembered that Andalucía is a relatively poor region in the context of the EU-27, having severe problems of convergence in income per capita with the remaining Spanish regions. Its growth pattern has been strongly based on employment growth, which has led to small (even negative) growth rates of productivity and negative results in terms of efficiency in the use of production factors.

A growth accounting methodology is used here, which breaks economic growth down into its main components and allows us to draw some conclusions. *First*, Spain is one of the least intensive ICT users within the EU-15 area and Andalucía is a less intensive user than Spain as a whole. *Second*, ICT assets account for less than non ICT assets in total market GVA growth. It is also found that the contribution of ICT to labour productivity growth exceeds that of non ICT assets. *Third*, once the different sectors of activity are grouped according their ICT deepening, and despite the fact that the share in GVA and employment generation has remained apparently constant across 1995-2004, the contribution of ICT to GVA growth and employment growth within the ICT intensive sectors has experienced a considerable increase in Andalucía. While 36.5% of total market GVA growth was produced in the ICT intensive group during the period 1995-2000, this percentage increased to 45.4% during 2000-2004. Concerning employment creation, these figures have risen from 20% to 25%, when considering the sub-periods 1995-2000 and 2000-2004. *Fourth*, growth rates and labour productivity levels are undoubtedly higher in the intensive ICT sectors. Productivity has been 82.7% higher in the ICT intensive sectors as compared with the non intensive ones in 2004. This gap in productivity has been increasing since 1995. *Fifth*, for a few intensive ICT service sectors, ICT assets have had an important contribution in both GVA growth and productivity growth.

From a policy viewpoint, the results provided by this study show that ICT can be seen as a lever for long-term productivity growth. The question is whether policies aimed at encouraging the use of ICT should be mainly defined on a national or European basis or, by contrast, we should think of regional tailor-made initiatives. These results also show that the regional dimension of ICT contribution to productivity growth is worth considering as substantial differences may arise, which could influence the long-term convergence of those EU regions lagging behind.

Further studies, like this one on Andalucía, should also be carried out for other EU regions in order to assess the extent to which technological change has an influence on regional development across the EU.

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Appendix A. Labour force qualification index growth rate

Consider first that labour force qualification is labeled by *k*. As productivity across different qualifications levels does not vary linearly, we will use the relative wage as a proxy the marginal rate of substitution. In Spain, estimations of relative wages are available through the Survey of Wage Structure (Encuesta de Estructura Salarial) for years 1995 and 2002. As our exercise is run over the 1995-2004, we have used that of 2002 as the pivotal year.

Then, the index is constructed according to the following expression:

$$\gamma_{st}^{KH} = \frac{1}{T}\left[\ln\left(KH_{st}\right) - \ln\left(KH_{st-T}\right)\right] = \sum_{k} \omega_{kst}\left(\gamma_{kst} - \gamma_{st}\right), \qquad \text{(A1)}$$

with:

$$\begin{aligned} \gamma_{kst} &= \frac{1}{T}\left[\ln\left(HL_{kst}\right) - \ln\left(HL_{ks,t-T}\right)\right], \\ \gamma_{st} &= \frac{1}{T}\left[\ln\left(HL_{st}\right) - \ln\left(HL_{s,t-T}\right)\right], \\ \omega_{kst} &= \frac{1}{2}\left[\phi\left(k,s,t\right) + \phi\left(k,s,T\right)\right]. \end{aligned} \qquad \text{(A2)}$$

and:

$$\begin{aligned} \phi\left(k,s,t\right) &= \frac{w_{kst}L_{kst}}{\sum_k w_{kst}L_{kst}}, \\ w_{kst} &= \frac{H_{st}}{H_{s2002}} \text{wage}\left(k,s,2002\right), \end{aligned} \qquad \text{(A3)}$$

where $\sum_k \Phi(k, s, t) = 1$. H_{st} is total hours worked by one unit of labour in sector *s* at time *t*, which we suppose identical for all levels of qualification *k*. On the other hand, wage (k, s, 2002) is average earning per worker with education *k* at sector *s* at year *t* = 2002, as estimated by the Spanish Survey of Wage Structure 2002. L_{kst} is total number of workers with level *k* of qualification in sector *s* at time *t*. Finally, notice that:

$$\begin{aligned} HL_{kst} &= H_{st}L_{kst}, \\ HL_{st} &= \sum_k HL_{kst}. \end{aligned} \qquad \text{(A4)}$$

Appendix B. Capital services and the cost shares of production factors

This appendix provides further details on the computation of capital services series and the cost shares of production factors that we have used in the growth and productivity accounting exercise. Capital series services have been obtained according to the three stages described in Section 4. Particularly, let $K(i)_{st}$ be the productive capital of asset I in sector s at time t. This concept of productive capital can be seen as a volume index of capital services. The expression driving the concept of capital services in sector s for the asset i is as follows:

$$VCS_{ist} = \mu_{ist} K(i)_{s,t-1}, \quad \text{(B1)}$$

where μ_{ist} is, in turn, the

$$\mu_{ist} = p_{is,t-1}(r_t + d_{ist} - q_{ist}), \quad \text{(B2)}$$

where $p_{is,t-1}$ is the price of asset i in sector s at $t-1$, r_t is the nominal interest rate and q_{ist} is the rate of variation of price of asset i. Data we have used to deal with these variables come from several sources. Productive capital $K(i)_{st}$ has been taken from Mas et al (2005) and according to the territorial allocation and projections for not available values explained in Section 4. The prices of assets $p_{is,t-1}$ have been elaborated on the basis of deflators provided by Mas et al (2005), and following the procedure they use for the Spanish case, that is, taking into account the US deflators for ICT assets and the relative prices between Spain and USA, as the OECD recommends to overcome the deficiencies of Spanish statistics. The nominal interest rate r_t consists of the sum of the rate of return (exogenously fixed at 4%, as Mas and Quesada (2005) do) and the inflation rate, computed as a three year centered moving average of the Andalusian RPI. Depreciation rate dist has been obtained according to the methodology of Mas and Quesada (2005). It has been computed as the ratio of investment resources devoted to depreciation over the wealth capital stock. Finally, q_{ist} measures what extent the prices of assets varies and has been calculated as the three year centered moving average of the variation of prices of assets. Once the capital services are available, we are able to compute the cost shares which are needed for the growth accounting exercise. Contrary to the standard approach, based on the "primal problem", we follow here a "dual approach". As we have used an exogenous rate of return in determining the capital services of productive capital, the estimates of TFP coming from the "primal problem" will not be the same than those of our methodology. Anyway, as Schreyer (2004) has pointed out, the approximation to equations (2) and (3) via cost shares is a reasonable technique which avoids some of the problems of the "primal problem", such as the need of obtaining econometric estimates of extent of returns to scale, of mark-up set over costs by firms, etc.

The expressions of cost shares are given by the following formulae:

$$\alpha_{lst} = \frac{RE_{st}}{TC_{st}} \qquad \text{(B3)}$$

$$\alpha_{ist} = \frac{VCS_{ist}}{TC_{st}}, \qquad \text{(B4)}$$

where RE_{st} is the remuneration of employees in sector s and TC_{st} is the sum of RE_{st} and VCS_{ist}. Mixed incomes have been reassigned into labour and capital according to the weight of remuneration of employees over the GVA. The next step refers to the way of computing the growth rates of each variable in the growth accounting framework. As was already said in Section 4, we have used a Törnqvist index to take explicitly account the changes in the capital structure of sectors. For instance, the growth rate of productive capital as a whole over the period between t and $t-T$ is given by the following expression:

$$\gamma_t^K = \ln K_t - \ln K_{t-T} = \frac{1}{T}\left[\sum_{i=1}^{6}\sum_{s=1}^{25}\nu_{it}\left(\ln K(i)_{st} - \ln K(i)_{s,t-T}\right)\right], \qquad \text{(B5)}$$

$$\nu_{it} = 0.5\left[\frac{VCS_{ist}}{\sum_{i=1}^{6}\sum_{s=1}^{25} VCS_{ist}} + \frac{VCS_{is,t-T}}{\sum_{i=1}^{6}\sum_{s=1}^{25} VCS_{is,t-T}}\right].$$

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Abstract
This study aims to measure ICT adoption in the Andalusian economy and to assess the contribution of these technologies to economic and productivity growth in the region. The topic of this research is highly relevant as, on the one hand, empirical evidence at the regional level is scant and, on the other hand, ICT and regions are at the core of the EU policy agenda. This study must be seen as a first step towards a regional approach to analysing the contribution of ICT to productivity and economic growth. The data and methodology used in the study are consistent with existing country-level studies and thus provide a useful starting point for further research addressing the impact of ICT on other EU regions.